P R O C E E D I N G S

of the

FIRST GENERAL MEETING

AMERICAN SOCIETY

of

SUGAR BEET TECHNOLOGISTS

Salt Lake City, Utah

January 11-13, 1938

PREFACE

The current report of proceedings has been prepared largely as a source of information for members of the Society. It contains results, summaries and conclusions from a vast range of experimental projects.

The freedom of presentation and discussion exhibited at the meetings, apparent in many reports contained herein, is ample evidence of the desire to obtain the facts and to discuss them with utter frankness to the ultimate good of a great industry. Cooperation, as seen in the sugar beet seed production in the southwest, naturally follows.

The distribution of this report will be limited to members, either individual or company, and as such will reach those who are in complete sympathy with the aims and purposes of the Society.

Some of the reports are but brief abstracts, in other cases complete papers are presented. It is hoped that this report may prove useful to you.

THE AMERICAN SOCIETY OF SUGAR BEET TECHNOLOGISTS

For two consecutive years previous to the winter of 1936-37, a Round Table was sponsored and organized by Extension Agronomist T. G. Stewart, Colorado State College, in cooperation with the Fort Collins office of the Division of Sugar Plant Investigations, U. S. Department of Agriculture. The purpose of these Round Table discussions was to direct attention to improved methods of sugar beet culture, to serve as a clearing house for ideas, and to develop more complete understanding regarding research and field experience between sugar companies, beet growers, and state and federal research workers.

At the Round Table in 1936-37 A. W. Skuderna was elected chairman of the program committee for the 1937-38 meetings. Mr. Skuderna appointed the following committee to assist in formulating the program: H. E. Brewbaker, J. E. Coke, C. E. Cormany, R. H. Cottrell, C. T. Lund, C. V. Maddux, Douglas Scalley and T. G. Stewart. The broad representation in this committee was specifically planned as a possible foundation for an enlarged organization.

The representation at the 1936-37 meetings at Fort Collins, Colo., Jan. 5-7, was more than national in scope, it including 2 men from Canada. There was a general discussion of the desirability of an organization to represent all the American sugar interests including the Canadian industry, at a banquet held in the Northern Hotel the second evening of the Third Annual Sugar Beet Round Table, Jan. 6, 1937.

A unanimous opinion was expressed in favor of such an organization.

At the closing session of the Round Table, Jan. 7, 1937, action was taken to organize the American Society of Sugar Beet Technologists to continue the work started by the Round Table, and to extend its membership throughout the industry in the United States and Canada.

It was voted to hold the 1938 meeting at Salt Lake City. The previous program committee was charged with the duty of drafting a constitution and by-laws for approval at the 1938 meetings, and with the selection of an executive committee and program chairmen. The officers, consisting of president, vice-president, and secretary-treasurer were elected in the final Round Table session. Action was also taken to form a committee on standardization of experimental methods to be appointed by the president. The local committee and editor were appointed by the president.

1936-37

OFFICERS AND COMMITTEES

President ..... A. W. Skuderna
Vice-President..... N. R. McCreery
Secretary-Treasurer.....H. E. Brewbaker

Executive Committee
(In addition to the three officers)

G. H. Coons	C. V. Maddux	W. W. Robbins
H. D. Brown	R. H. Cottrell	J. E. Coke

Program Chairmen

General Program Chairman..... A. W. Skuderna
Genetics and Breeding.....F. V. Owen
General Agronomy.....H. E. Brewbaker

Local Committee

R. H. Cottrell	R. H. Harris
J. E. Ellison	Thomas Heath

Douglas Scalley, Chairman

Committee on Standardization of Experimental Methods

J. E. Coke	S. B. Nuckols
F. V. Owen	C. W. Doxtator
H. W. Dahlberg	H. E. Brewbaker, Chairman

Editor

W. D. Porter

OFFICIAL GUESTS OF THE SOCIETY

In an effort to broaden the scope and increase the value of the meetings to the members of the Society and to the ultimate sum total of information for the industry, several of the sugar beet companies contributed to bring two outstanding scientists to the Salt Lake meetings.

Dr. Harry B. Walker, Head of the Division of Agricultural Engineering, University of California, discussed the future of sugar beet production machinery in an address before the general session at a dinner meeting. He pointed the way toward possible elimination of "stoop" labor.

Dr. F. R. Immer, Geneticist and statistical advisor, Agronomy and Plant Genetics Division of the College of Agriculture, University of Minnesota, discussed the newer methods of variety testing in an informal address before the "Methods" section; general considerations with regard to field plot and research methods at a general session; and the "Minnesota System for testing and recommendation of varieties" before the "Varieties" section. He also assisted the Standardization Committee in formulating its recommendations to the Society.

A word of commendation is due these men for giving of their time, to the institutions which they represent for their cooperation, and to the sugar companies who made it possible to bring these scientists from related fields to the meetings.

GREETINGS SENT TO I. I. R. B.

Soon after arriving in Salt Lake City the officers of the Association sent greetings to L'Institut International De Recherches Betteravieres (I.I.R.B.), a similar body of technologists, meeting at Brussels, Belgium. Following is a copy of the cablegram, together with a copy of the reply.

GREETINGS

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NO I BRUSSELS (BELGIUM)

AMERICAN SOCIETY SUGAR BEET TECHNOLOGISTS IN SESSION SEND GREETINGS AND WISH YOUR CONFERENCE SUCCESS

H E BREWBAKER SECRETARY.

COPY OF CABLEGRAM

7VG 26 NL 3 EXTRA VIA RCA

CD TIENENBELGIE 19 VIA SALT LAKE CITY UTAH

JAN 20 1938

NLT HE BREWBAKER

SECY AMERICAN SOCIETY SUGAR BEET TECHNOLOGISTS

CARE GREAT WESTERN SUGAR CO L G

OUR SESSION WAS DELAYED AND YOUR CABLE HANDED ONLY TODAY MANY THANKS FOR KIND GREETINGS WE HOPE YOUR CONFERENCE WAS A GREAT SUCCESS

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Douglas E. Scalley, general agricultural superintendent for the Utah-Idaho Sugar Company, called to order the first session of the first annual meeting of the American Society of Sugar Beet Technologists at the Hotel Utah, Salt Lake City. Mr. Scalley introduced A. W. Skuderna of the American Beet Seed Company, president of the Society, who welcomed the delegates. President Skuderna then introduced Dr. E. G. Peterson, president of the Utah State Agricultural College, who gave the address of welcome.

ADDRESS OF WELCOME

President E. G. Peterson
Utah State Agricultural College

In saying a word of welcome to the members of the American Society of Sugar Beet Technologists, I am reminded that you have come for this first annual meeting to a place of great historical interest because it was just three blocks from this meeting place that irrigation by Anglo-Saxon peoples was first practiced. Irrigation is, of course, the basis of the production of some of our most important crops, including sugar beets, so it is fitting that for the moment we recognize our obligation to the development of civilization in areas of low rainfall to the little group of weary Mormon pioneers who ninety years ago first led water from its natural bed out onto the land in order to enable them to grow crops in a land which without irrigation would have continued largely the abode of Indians, trappers and wild animals.

Irrigation obviously was valuable for many reasons; I venture to say that second only in value to the food which it provided for the increasing thousands who sought new homes in these valleys, its demonstration of the efficacy of human cooperation was its greatest value. The development of irrigation made cooperation a necessity; it would succeed only if people recognized that their welfare was bound up with the welfare of the whole.

Education and research is one expression, and undoubtedly one of the greatest in human society today, of the validity of the cooperative effort. Here on a grand scale, men agree to pool their resources and put other men, especially prepared, to work for them and in the interest of all society. It was a great day in history when we decided to do these things instead of continuing the intellectual and spiritual squalor of the centuries past when we had not only denied the validity of science and truth (unless it happened to conform to our established opinions) but actively persecuted the seeker of truth. There are no more pitiable and beautiful spectacles than the sacrificial fires, the dungeons, the blighting social ostracism, the cup of hemlock and that terrible but glorious cross by means of which over the centuries we have sought to glorify our stupidity and the evil in us and delay the advance of truth. The beauty and the glory of it is in the willingness of men, then, as now we hope, to go with smiles upon their faces into the flames that the truth which was in them might live.

The sugar beet industry of Utah and Idaho was saved by science. In 1905 Dr. E. D. Ball, then Professor of Entomology at the Utah State Agricultural College, now Entomologist at the Arizona Experiment Station, discovered that the leaf hopper was associated with curly-top problem. In 1907 Dr. Ball published his results and in 1918 work began on the breeding of disease-

resistant beets. This work of Dr. Ball was the first to demonstrate an insect transmitted plant disease, a discovery of far-reaching importance. This discovery and the following successful breeding of disease-resistant seed account for the fact that Utah and Idaho sugar factories are operating today; they would all be closed undoubtedly if this victory had not been achieved by the plant breeders.

I am informed that the companies now engaged in the manufacturing of sugar, are cooperating thoroughly in the battle which science must continually wage if we are to be successful in our battle to subdue the earth and make it minister to the increasing demands of human society.

Intelligent observers are becoming more and more conscious of the need of cooperation in human society if we are to win the battle against anarchy and chaos. America itself, rich as we potentially are in almost all the necessary resources out of which to create goods and make possible the services which an advanced civilization requires, presents the sorry spectacle of ten or eleven million unemployed and a growing sense of the futility of much that we have done to maintain our self respect and our leadership in the world. We are only six percent of the people of the world and yet we have nearly fifty percent of its essential resources. Our danger obviously is not in absence of food, clothing and shelter, and educational opportunity, enough for all of us but rather in our lack of ability to see that these necessities reach the people. In this we have shown fearful incapacity. That incapacity is in government and in the economic arrangements which have grown up in a land so rich that greed and avarice have become too largely the motive in development of civilization.

The profit motive has been a major contributor to our economic success as a nation. Controlled and subordinated the profit motive can continue greatly to serve us. Uncontrolled, it bids fair to wreck us because if uncontrolled this motive easily degenerates into greed. There are two ways to control it; by government as may be necessary and is of course necessary in considerable degree, but preferably by the conscience of man because of devotion to something more important than gain.

America with all our faults is still the hope of the world. If we can render ourselves worthy of our freedom, and our great riches, we can do much to save a civilization now threatened with extinction. If we show ourselves to be worshippers of wealth and ease and indulgence, we will record the greatest tragedy the world has ever witnessed because the world desperately today needs the help of America in preserving its inheritance of freedom and democracy. Our opportunity for world service is the greatest that has ever come to a people; our difficulties are commensurately great. We, if we can rise above brute selfishness, can save ourselves and by our example do much to save the world as it faces probably its greatest crisis.

RESEARCH IN THE DIVISION OF SUGAR PLANT INVESTIGATIONS U. S. D. A.

E. W. Brandes, Chief

E. W. Brandes, Principal Pathologist in Charge, Division of Sugar Plant Investigations, U.S.D.A., gave an informal, extemporaneous address on research of the Division, tracing the development of work on sugar beets from 1918 to the present.

The purposes and results of four main projects and numerous accessory projects were presented. The principal projects are: Study of the causes of reduced stands and other losses mainly due to disease; breeding for resistance to curly top; breeding for resistance to leaf spot, and investigation of principles involved in sugar beet seed production in North America.

Progress in solving these problems includes restoration to productivity of 100,000 acres of land by development of curly top resistant strains, inauguration of an American beet seed industry which now supplies nearly two-thirds of the national requirement and conserves millions of dollars that formerly flowed to central Europe for purchase of seed, definite advances in the development of strains of beets resistant to leaf spot and development of practices that curtail the losses heretofore caused by minor diseases.

The accessory projects mentioned were botanical investigations in the fields of plant anatomy, cytology and physiology, ecological studies in connection with curly top control, study of agronomic methods and plot technique, testing of sugar beet varieties by application of these methods, and studies in sugar beet genetics and biometry.

Some remarks were made on the organization of the U. S. Department of Agriculture in relation to functions of various Bureaus and Services other than the Division of Sugar Plant Investigations that give attention to problems of the sugar beet industry.

SUGAR AND WESTERN CIVILIZATION

Governor Henry H. Blood

Consideration of the human side of the sugar industry may enable the sugar technologist to see his work in its true perspective, to perform it more intelligently, and to find pride and joy in the service he and his associates are rendering to mankind. Although I am not unacquainted with this human side of the sugar industry, I know something about its beginnings in the West; something of the farmers' viewpoint; something of the processors problems. One hundred years ago this great basin district was a land where the deer and antelope played on the foothills and the buffalo roamed the plains—an arid land, bathed in sunshine, covered only with sage brush and sunflowers and such other vegetation as might exist along the water channels, or was able to withstand several months of summer with only an occasional shower.

The other day I participated in the relocation of a plaque commemorating the birth of irrigation as it is practiced in the modern west. The date on that bronze memorial is July 23, 1847, not yet ninety-one years ago. But even before Brigham Young passed through the gap in the mountains which we now know as Emigration Canyon, and told his followers, "This is the place," the advance guard of that band was endeavoring to plow and prepare for planting a soil so hard that it broke their plowshares. Necessity brought trial of something new. The new comers dammed one of the branches of a stream they later called City Creek and softened the soil by flooding it. Thus irrigation was commenced here. Irrigation has meant everything to the sugar industry in Utah.

We do not understand aright the history of the sugar industry in Utah unless we have some comprehension of the character, and viewpoint and determination of the early settlers of this state.

Pioneers were ambitious, adventurous, aspiring. They learned to depend on themselves and developed ingenuity in their daily tasks and in their relations with their associates. Eager to live their own lives and to advance their station and fortune, they were receptive to new inventions and new ideas—anything that would lead to a solid, enduring and high type of civilization.

Some of the arrivals in the first company to reach Salt Lake Valley were from Mississippi, and perhaps knew a little about the manufacture and the value of sugar.

Brigham Young, then governor of the newly formed territory of Utah, in his address to the Legislature of 1852, said: "Let home industry produce every article of home consumption," and again:

> "Produce what you consume; draw from the native elements the necessities of life."

The Governor asked for passage of laws to protect local industries and to encourage manufacturing interests.

There was need for home production. It is recorded that one Captain Grant, a representative of the Hudson Bay Company from Fort Hall, Idaho, sold coffee and sugar at $1 a pint. In Salt Lake forty cents a pound appears to have been a prevailing price for sugar. The Deseret News advised its readers to "let all trading shops severely alone, where they ask you forty cents a pound for candles, forty cents a pound for sugar and soap----and will only give you ten dollars a ton for hay." The latter medium of barter, the News said, had a fair market price of fifteen dollars, and would soon reach twenty dollars a ton.

The year 1852 was a noted one for several reasons in this mountain region and ambitious plans were afoot. In August of that year machinery arrived in Utah for the construction of a sugar factory.

I am indebted to the Utah Idaho Sugar Company and particularly to Mr. Scalley for most of the details in the following account of that venture, the chief vestige of which survives in the name of Sugarhouse, given to a thriving business center in the southeastern part of Salt Lake City, I quote from Mr. Scalley's notes:

"When John Taylor, one of the European missionaries of the Mormon church, learned of the strides made by the beet sugar industry in France, he and an associate, Phillip Delamar, persuaded the Deseret Manufacturing Company to purchase from Faucett, Preston and Company, of Liverpool, for $12,500 a complete outfit of machinery for making sugar. This equipment, accompanied by the late Elias Morris, arrived in New Orleans in April, 1852, from where it was taken on another boat to Fort Leavenworth, Kansas. Here it was loaded into covered wagons drawn by fifty two ox-teams. (Another authority says 200 yoke of oxen). At that time the cost of hauling freight from the Missouri river to Salt Lake City was five hundred dollars per ton. From the river to Utah was a slow and painful journey, and it was not until late fall that the party conveying the machinery arrived, hungry and cold, at the Green River, Wyoming. There it was met by a detachment sent out by Brigham Young, and the remainder of the journey to Provo, Utah, where it had been decided to erect the sugar factory, was made in comparative comfort. Five hundred bushels of beet seed had also been sent with the machinery.

"However, the expense of the enterprise was more than the Deseret Manufacturing Company had expected. The machinery was, therefore, purchased by the Mormon Church and moved to Salt Lake City, where it was installed in an adobe building at the outskirts of the city, later known as Sugarhouse."

In 1853 additional machinery was received; a small crop of beets was raised, and the attempt made to produce marketable sugar. Right here sugar technology was sorely needed but, unfortunately, was not available. Undoubtedly, through lack of experience, technical knowledge of the manufacturing process and probably because of inadequate machinery, the effort failed. The factory produced only a syrup, due to the difficulty that was experienced in getting sugar to crystallize. The syrup was so sharp in flavor that (and here my authority uses quotation marks) "It would take the end of your tongue off."

The initiation of one factory does not make an industry; nor was Utah the only state in the Union, as you gentlemen will know, which did not succeed at first, and tried again. The settlers from Vermont, New York and other territory had had some experience with maple sugar; those from the south may have known about cane sugar production, and Utah was drawing its share of population from other sugar areas. Sugar cane and sorghum provided some substitute for the granulated product in molasses and even a variety of raw sugar. Meanwhile the study went on, and though railroad and other transportation improvements reduced the price of sugar, Utah still had men of vision who could realize some of the possibilities of home production of this essential of modern life.

Among these was Arthur Stayner, whom I recall very well. I remember seeing a container, in the possession of his son, Arthur, Jr., once my school teacher, said to hold the first refined sugar successfully produced in Utah. But Mr. Stayner did establish a mill at Farmington and later at Spanish Fork about 1886 or 1887, and produced sugar from sorghum cane. He was successful in obtaining a territorial bounty, and a diploma. His enterprise otherwise was not a commercial success; but he later turned his attention to beet sugar, succeeded in interesting the authorities of the L.D.S. Church and the Lehi sugar factory of the present Utah-Idaho Sugar Company is the result. That enterprise was commenced in 1891 and began production in November of that year, thirty-eight years after the Sugarhouse factory had been given its trial.

It is remarkable, perhaps, as the first sugar factory ever constructed using American-made machinery, previous attempts having relied on French or German machines. It is also said to have been the first to use beets grown by irrigation.

The first year the output was about 11,000 bags; by the third year this had been stepped up to 41,000 bags. Ultimately the factory more than paid its way, and about eight years after its construction the company began its program of expansion which has carried its activities into several states. Other states have surpassed Utah as beet sugar producers, but this state still ranks high, as you know.

The industry has its problems, to aid in their solution we look to you technologists for help and assistance. Your skill and vision and inventive genius have brought sugar manufacture to its present standing.

The field is yours, technologists. For what you have done we honor you and thank you. For what you may still do we shall be deeply grateful.

THE DEVELOPMENT OF THE SUGAR INDUSTRY IN UTAH

Heber J. Grant, President of the L.D.S. Church

President Heber J. Grant of the L.D.S. Church gave an extemporaneous address on the early struggles of those connected with the sugar beet industry in the West. He told of the establishment of a factory at Lehi, Utah, which was wiped out by the depression of 1883; of his endeavors to raise capital for building another factory and the final interest taken by Wells-Fargo Company and the late David Eccles. He eulogized the pioneers of the sugar beet industry and held out high hopes for its future development.

LOOKING FORWARD TO BETTER SUGAR BEET PRODUCTION MACHINERY

H. B. Walker
Agricultural Engineer, California Agricultural Experiment Station

Aristotle, the famous Greek philosopher, defined hope as a waking dream. For many years the producers and processors of sugar beets have lived in the hope that some genius, philanthropist, scientist or inventor might devise suitable equipment and machines, which would eliminate from sugar beet production problems, the back-breaking, tedious stoop labor which now seems to be necessary for growing this crop. Our progress in overcoming these problems has been slow. We have yet to find the talent and the method of attack to bring to reality this waking dream.

The sugar beet industry, however, has not attained the hopeless stage. This sugar beet machinery problem is very much alive and, therefore, still in the hopeful stage.

I am more than conscious of the tremendous amount of thought, energy and money which has been put into the various machinery phases of sugar beet production by beet sugar companies, inventors, implement companies, research workers, farmers and others. It is a problem which has challenged some of the best minds of the country and certain progress has been made, but still the industry is unserved, and may I say, unconvinced that a practical answer can be found to meet the increasing hazards of stoop labor crop production.

I shall divide my discussion into three parts: (1) the need of better machinery, (2) the possibilities of securing better machines and (3) suggestive methods of attainment.

This problem of providing better machinery for sugar beet production is meritorious because it involves an industry in which both the producer and the processor of the crop are vitally concerned. It involves also the future security of a crop in our agricultural system which has been found not only useful as a source of raw products for a necessary food staple, but it is a crop which fits into good farming practices, involving appropriate crop rotations, soil management, weed control, livestock production and other vital practices connected with good land use policies. These, however, are only indirect influences which have developed the urge for better machinery. The farmer who produces crops, making intermittent demands on labor, and particularly where this labor is of the stoop type, seems to be facing rather serious problems. These, likewise, are reflected into the industry which processes the raw products of the farm.

Farmers have two important costs which must be considered and successfully met in any farm enterprise. These are, the fixed charges and the operating costs. In the former we have such things as interest, taxes and rentals. The second represents labor, power and machinery charges and these are costs in which the farmer as an individual is most interested, because ordinarily he can do more about these than the other.

The operating charges include labor, which in the beet industry, represents a considerable proportion of the total operating costs. Labor charges are now somewhat different than in former times, due to the unusual tendency in these modern times of social consciousness, to regulate hours of work and to fix minimum rates of pay. This tendency has the potential effect at least, of increasing fixed charges if hired labor in any volume is required in growing the crop.

Hand labor is very important in the growing of beets and most of this labor is required at critical periods during production, that is, during the blocking and thinning period following planting, and later during the harvesting period. These, likewise, are stoop labor periods. The character of the labor required and the intermittent demand for such labor has focused rather unfavorable attention on the industry.

The public attention which has been focused on "the more abundant life" and the underprivileged groups, has prompted legislative attempts to fix the hours of labor and the rates of pay so that in effect, all farmers are facing the possibility of adding certain wage increments to his fixed charges.

These matters are serious enough in themselves, but with these changes, farmers are faced with the additional hazards of labor unrest, organized labor

groups, and organized resistance to the profit features of the production enterprise. The labor problem, therefore, becomes a vital issue in the future of the industry.

Reformers, of course, object to the use of labor saving production equipment on the grounds of technological unemployment, but this industry cannot afford to be idealistic when we have acres to cultivate, factories to operate, interest charges to meet, and taxes and wages to pay.

Labor charges are important, particularly hand labor, which represents from two-thirds to three-fourths of the total man hours required to produce a crop. Likewise, a high proportion of this labor, more or less specialized as to type, places the industry in a particularly vulnerable position should issues arise between growers and organized labor groups. Top this out, if you please, by the fact that certain labor costs may, in a way, take the form of fixed charges like taxes, rentals, insurance, etc., and it becomes apparent that the principle of self-preservation dictates to the industry the necessity of doing what it can directly, to overcome these unfavorable factors.

Apparently, there is but one clear path to travel in combatting these handicaps, that is, to reduce, if not overcome entirely, stoop labor in sugar beet production by the substitution of machine methods.

We now come to the second phase of this problem which calls for a review of the possibilities of finding, or developing, machines to relieve the peak labor demands of sugar beet production and to relieve the industry of the "so-called" stigma of stoop labor. This is not a new problem as you well know, neither is it one that has not been thought of before. Some of these problems have been in the minds of producers as long as we have had the sugar beet industry. The plant breeder, agronomist, plant pathologist, entomologist, practical farmer, sugar chemist, field superintendent, engineer, inventor and others may have contributions and if so, these should be integrated into the solution of the problem we are discussing tonight. Failure to consider the viewpoint of any one of these may result in disappointing achievements.

May we consider for a few moments the particular problems of blocking and thinning beets. Immediately we are concerned with seed germination, damping off of seedlings, the effect of doubles, economic spacing and other factors not directly connected with the mechanical problems of blocking and thinning. In fact the recent work of Mervine and McBirney (U.S.D.A.) with planters of the single beet seed placement type appears to be a foundation start toward the subsequent tasks of blocking and thinning.

It is believed that improved planting equipment of the single seed drop type using graded seed may make possible the final thinning by long handled hoes thus eliminating the undesirable stoop labor. The Spring peak demand for stoop labor undoubtedly can be reduced by the development of new types of farm machines and continued progress may be anticipated because this phase of machinery development is not so expensive and work thus far has produced encouraging results.

The harvesting problem is not simple and it is not likely that it will be quickly or easily solved. In this project there are two operations which must be completed separately or simultaneously. These are topping and lifting. The general inventive approach has been principally along the line of topping the beets in place with subsequent lifting, but in recent years

considerable development work has been achieved with machines which lift the beets first and subsequently top them. Topping beets in place has been a difficult task to accomplish satisfactorily, particularly where stands are thick and with the beets spaced more or less regularly, due to inequalities in crown elevation and beet sizes.

While I have a feeling of optimism toward the ultimate success of the harvesting machinery problem, I also realize there can be no definite forecasts of the ultimate outcome. It is a most difficult problem on which many excellent and capable persons have worked without complete success.

We now come to the third phase of this discussion: Suggestive methods of attainment? While I perhaps lack the courage and foresight to forecast the ultimate outcome I do believe a carefully planned cooperative project involving science, industry and agriculture offers more promise than any other of bringing to fruition the objectives sought.

The time has arrived to depart from the independent and perhaps the unrelated method of approach by some cooperative arrangement which will bring about a pooling of talent, funds, equipment, and ideas for a common purpose, that is, to get the best answer possible in the shortest time.

It would appear feasible, sensible and appropriate for these various agencies to get together on a program which would make possible the fullest utilization of facilities and talent at our experimental stations supplemented by special research grants from the industry, to work on these vital problems.

LIGHT AND BIOLOGIC EFFECTS

H. T. Plumb
General Electric Company

Everything of material value comes to us on a beam of sunshine. An abundance of sunshine means health, happiness and prosperity. Absence of sunshine results in darkness, ignorance, sickness and eventually death. Since sunshine means so much to everyone it is important to know about sunshine.

Practically all of the energy on earth arrives in the form of light from the sun center of our planetary system. The sun radiates in every direction through space while our earth intercepts only a small portion of the total energy. However, that portion amounts to one horsepower for every square yard of the earth's surface, or to about one man-power for each square foot on which we stand when the sun is shining down. Every second the total sun energy reaching our earth is more than was in all the coal ever mined in America.

The sun energy is radiated in the form of light, not as heat. There is no heat present until the light waves are stopped by the earth or the earth's atmosphere. Without sunlight we would all perish within a few hours. Sunshine keeps us well and, properly used, sunlight will cure our sicknesses.

Captured Sunshine: For years we have known that green leaf chlorophyll uses sunlight in the chemical manufacture of starch and sugar and all our foods, but not yet is the process fully understood. Nor have the most effective wave lengths for that purpose been determined. We do know that infra-red alone is insufficient. Red makes plants tall and spindling. Blue does the opposite, and ultra-violet light can make green apples red. Very short waves may be harmful, Bio-chemistry of light is little understood. Do you know which color of sunlight makes the best beet seed? And why? Humans like yellow light. Perhaps plants prefer some certain color of light. When such mysteries are solved we may learn how to manufacture foods directly from air and water with the assistance of light and electricity.

It has been found that plant seeds treated with X-rays produce changed plants and entirely different flowers. Maybe monochromatic light may have a similar effect. Mr. C. N. Moore of the G.E. Research Laboratory treated bulbs of regal lilies with varying doses of rays. Among the plants from treated bulbs were a few monstrosities which offered no desirable possibilities; progeny of two of the bulbs that had received doses of X-rays produced flowers with non-shedding anthers. Each succeeding year has seen the new strain continue true. Bulbs and bulblets from these two bulbs have continued to bear nondehiscent flowers--the property is now a fixed character, and a new variety of the regal lily exists. (Show Photograph.)

Photo-chemical effects which enable the retina to stimulate the optic nerve occur in a substance called "Visual purple" which is bleached by light but quickly regenerated or resensitized in normal eyes.

The retina is supposed to have evolved from ordinary skin. And we find that skin on all other portions of the body has certain photo-chemical reactions. Vitamin "D" is evolved from ergosterol and this energized compound seems to have a catalytic action stimulating other important chemical reactions.

In a similar way ultra-violet is believed to cause Vitamin "A" in the yellow pigment of grains, called carotin; and to generate Vitamin "B" in the outer layers of rice grains.

Moreover it has been found that irradiation of milk, cheap fats, fish meat, and bran, make better food values. And these are stronger for ricket prevention than ordinary codliver oil.

Ultra-violet increases egg production by poultry, milk by cows, and work by humans. It increases the bacteria destroying white corpuscles in blood. Photo-spectrographic analysis is now being used in place of direct chemical method. It is quicker and in many cases is more accurate. Photography by invisible light has overcome many optical difficulties. Microscopy with ultra-violet and infra-red has revealed organisms which are invisible by visible light. Infra-red filters which stop ultra-violet rays have made possible long distance photography by excluding the obscuring blur due to moisture and dust in the air.

In summertime ultra-violet sunlight prevents sickness and helps keep us well. The infra-red rays are very helpful in curing sprains, bruises, coughs, colds, and other congestive diseases. It happens that infra-red and visible light can penetrate into the human body a distance of about one inch. When we have long exposure to sunshine or to "heat" lamps, this penetrating

light energy reaches the muscles, is transformed into heat energy which expands the capillaries, lets new blood course through the veins to wash away the congested poisons of disease and bring new strength to the sick parts.

(Here follow experiments with infra-red light, filters, radiometer, photo-cells, et cetera.)

THE IRRIGATION OF SUGAR BEETS

L. D. Doneen
Irrigation Investigation University of California

The preliminary work on sugar beet irrigation has been conducted at Davis, California. For the past four years thirty 20th-acre field plots have been used in the experiment. Experimental procedure has been to maintain widely different soil-moisture conditions and to measure the effect on growth, yield, and sugar content of beets. In some of the plots the soil moisture content has been maintained at a high level by frequent irrigations. In others the beets have been allowed to deplete the moisture to the permanent wilting percentage and irrigation has been withheld until a decided evidence of water shortage could be observed. Other treatments include plots in which the soil-moisture content was allowed to drop to a certain percentage within a specified depth of soil.

The results obtained the first four years are in agreement. Representative results for the four outstanding treatments for the four years are given in the following table.

Yield, percent sugar, number of irrigations, acre-inches water, dates of irrigation, for four irrigation treatments of sugar beets at Davis.

Treatment	Yield tons per acre	Percent sugar	Number irrigations	Acre-inches water applied	Dates of irrigation
			1933		
1	13.3	15.3	1	15.0	June 15
2	24.4	15.5	7	35.9	May 24, 26, June 6, 15, 22, July 1, 12
3	22.6	15.2	4	33.8	May 14, June 6, 22, July 12
4	22.5	14.2	3	32.2	May 26, June 22, July 12
			Harvested July 20		
			1934		
1	28.7	17.4	1	13.2	June 28
2	41.6	17.1	8	46.0	April 20, May 10, 31, June 15, 29, July 6, 24, August 7
3	42.4	16.7	4	37.1	May 9, June 8, July 9, Aug. 3
4	37.3	17.5	3	32.0	May 17, June 20, July 16
			Harvested August 20		

(Continued next page)

Treatment	Yield tons per acre	Percent sugar	Number irrigations	Acre-inches water applied	Dates of irrigation
			1935		
1	12.6	14.7	1	13.5	July 16
2	27.6	16.4	6	30.1	May 16, 29, June 14, July 5, 22, 30
3	23.4	16.4	3	28.0	May 28, June 24, July 17
4	22.5	15.5	3	25.1	June 6, July 8, 30
			1936		
1	10.0	16.8	1	9.1	
2	19.3	17.1	7	32.5	
3	17.9	17.7	4	31.2	

Treatment 1 - Soil was allowed to dry and the beets wilted for approximately a month, one irrigation.

Treatment 2 - Moisture was maintained at a high level in the soil by frequent irrigation.

Treatment 3 - The soil moisture was allowed to drop to within about 2% of the permanent wilting percentage in the soil occupied by the roots and then the soil was irrigated.

Treatment 4 - The soil moisture was allowed to drop to the permanent wilting percentage in the soil occupied by the roots before the soil was irrigated--occasionally slight wilting occurred in this treatment just before irrigation.

The yields are nearly the same for all the irrigation treatments in which the soil moisture was maintained above the permanent wilting percentage. There was a reduction of about 50 percent in yield when the beets remained wilted for about a month. Sugar and purity content of the beets was approximately the same at harvest time in all treatments and did not seem to be affected by irrigation.

Root distribution studies revealed that beets first wilt when the readily available moisture is exhausted in the top four feet of soil. At this time the beets were about half grown. During the latter half of the growing period the sugar beet roots will develop into the fifth and sixth foot and will use all the readily available water at this depth.

The percentage of sugar in the beet during the growing season showed no appreciable differences in the different treatments except where the beets were allowed to remain wilted for a month before irrigation. During the period of wilting the sugar content increased about 5 percent over that in the irrigated plots. After irrigation they lost what had been gained during the wilting period and the final sugar content was approximately the same in all plots.

During the year 1936 and 1937 four field plots were established in different sections of the state and on various soil types. The results are

the same as those obtained at Davis, namely, that the yield and content of sugar in the beets was not affected until the soil moisture had reached the permanent wilting percentage; and the first wilting does not occur until all the readily available water has been extracted from the top four feet during the first part of the growing season. During the latter part of the growing season water will be extracted to the depth of six feet. The results indicate the rational system of irrigation is one in which water is applied just before the soil moisture is exhausted. Such a system is probably most economical since waste is lessened by less frequent application of water.

SOIL MOISTURE STUDIES IN CALIFORNIA

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The influence of soil moisture variations on the development of weight, sucrose percentage, purity, and nitrogen of the sugar beet root was studied in tests conducted in the Sacramento, San Joaquin and Salinas Valleys of California by the Spreckels Sugar Company during the two seasons, 1936 and 1937. As a result of these studies, an attempt is being made to establish an accurate basis for determining irrigation procedure in commercial beet fields.

While the primary purpose of this discussion is to show soil moisture conditions as they existed in normally irrigated commercial beet fields in California and to discuss the procedure developed to improve irrigation practices, a summary of the more outstanding and practical results secured from the detailed study of soil moisture and beet growth is of importance.

Plots for this study were located at Woodland, Manteca, Salinas, and King City in 1936 and 1937 and were conducted in cooperation with the Division of Irrigation, University of California. At each location two plots received four hundred pounds of Ammonium Sulfate per acre and two received no fertilizer. Also two plots received irrigation treatments differing from another set of two plots. At two-week intervals sixty beets from each plot were removed for weighing and analysis. These beets were taken from six different locations in each plot.

Conclusions drawn from these studies are as follows:

1. The maximum growth of beet root and maximum development of sucrose and purity were secured when soil moisture was maintained, throughout the growing season, above the permanent wilting point and below the moisture equivalent for the majority of the soil column in which the roots penetrated. Under normal conditions the roots, by the middle of June, were removing soil moisture from at least the first six feet of the soil column, the depth to which moisture determinations were obtained in this study. When soil moisture was maintained above the permanent wilting point but below the moisture equivalent, the rate of root and sucrose development was not greatly influenced by the quantity of moisture in the soil.

2. When soil moisture was maintained above the permanent wilting point the application of irrigation water to the soil did not result in a significant reduction of the sucrose percentage of the beets, except late in the season, when the sucrose percent was temporarily lowered. In the majority of cases, irrigation in the later part of the growing season resulted in a decrease in sucrose and approximately two weeks were required to regain the loss.

3. The rate of development of weight of root and sucrose was retarded or stopped entirely when the major portion of the soil column reached the permanent wilting point. Purity, which developed more rapidly and reached a maximum point earlier in the season than either sucrose or weight of root, was, in these tests, not materially affected by soil moisture variations as it had usually reached its limit previous to any major moisture deficiency.

4. A soil containing moisture above its full capacity for any large portion of the rate and area normally supporting roots produced crops of low yield and sucrose content.

5. The application of ammonium sulfate at the rate of four hundred pounds per acre, applied as a side dressing at the time of seeding, resulted in increased yields when sufficient moisture was available to support the increased growth caused by the nitrates. When the soil moisture of any appreciable area in which the roots were located reached the permanent wilting point and remained there for a considerable period, the effect of the application of the nitrogen was nullified and no increase in weight of root was noted. The extent to which this nullification took place depended on the length of the period the soil column was maintained at the permanent wilting point.

6. The ammonium sulfate applied in these tests did not result in a lowering of the purity of the beets. In certain cases the sucrose percent was slightly less in fertilized plots than in unfertilized plots.

It is safe to conclude, after reviewing the moisture conditions in these typical fields that:

1. Of approximately equal responsibility for low yields is the practice of maintaining an excessive (above the full capacity) and a deficit (to the permanent wilting point) soil moisture supply.

2. More accurate methods must be developed for determining when and for how long water should be applied to land than by observing the growing crop or kicking a surface clod. Irrigations applied too frequently increase costs and result in a water-logged soil. Irrigations delayed to a point where the majority of the soil column reached the permanent wilting point retarded root and sucrose development.

BED OR RIDGE PLANTING IN SUB-IRRIGATED AREAS

J. E. Jensen
Utah-Idaho Sugar Company

In many areas the soil is being broken down to a point where it is failing to produce adequate crops, a condition that is not entirely due to a lack of fertilization, but a condition that calls for a change in our agricultural practices.

Some leading Agronomists contend that so much attention has been given in preparing and furnishing food for the soil and the plant that we have disregarded or taken for granted the proper conditioning of the soil so as to make available to the plant the maximum benefit of such food.

On sub-irrigated lands this condition has become more noticeable; low yields are compelling growers to give the matter serious consideration. The sub-irrigated land becomes so packed and waterlogged that it remains quite damp and cold during most of the growing season, and that regardless of high expenditures in applying commercial fertilizers, poor yields continue.

Just recently I called on a grower who was experiencing difficulty in obtaining a satisfactory production. His land was free from disease and very highly fertilized. The physical condition of the soil was so compact that there seemed to be no circulation, and a very bad bacterial environment prevailed. This grower had concluded that in order to liberate the plant food he must change his cultural methods, and took very kindly to the idea of ridging his tract of land in the fall for early spring planting.

The following data furnished by six farmers, growing beets on sub-irrigated land show an increase in production on ridge planting:

Henry Roberts	Increase	3.0	tons	per	acre
William Roberts	"	2.3	"	"	"
Frank & Silas Spaulding	"	4.2	"	"	"
Douglas Taylor	"	3.1	"	"	"
Earl S. Hall	"	3.6	"	"	"
Melvin Luke	"	1.2	"	"	"

These gentlemen are enthusiastic over ridge planting. They claim a longer, more uniform sized beet and the plants remain thrifty, and in an ideal growing condition throughout the season; whereas, with regular planting, a short stubby beet is grown and the tops turn yellow in early August thus retarding the growth of the beet.

The deep fall ridging permits the elements to play a more important part in breaking up the soil into smaller fragments, liberating the plant food and aiding its availability to the plant.

THE EFFECT OF SPACING AND DENSITY OF STAND ON HILL PRODUCTION OF SUGAR BEETS

F. G. Larmer, Division of Sugar Plant Investigations
Bureau of Plant Industry, U. S. D. A.
(Read by Title)

In the experiments to which I refer, sugar beets were grown in hills or clumps and results compared with the conventional single-plant method. In the first experiment four treatments were compared with very carefully spaced single beets 10 inches apart. Contrasting treatments were (a) hand blocking, 10-inches spacing, with no finger thinning, (b) doubles in hills spaced 10 inches apart, (c) doubles in hills spaced 20 inches apart.

The second experiment compared hand blocking (a, above), and hand blocking, the hills being 20 inches apart, with contract labor thinning and carefully supervised thinning.

In the third experiment hand blocking (a, above) and mechanical cross cultivation, the hills of beets being 20 inches apart, were compared with single-plant thinning on three rates of seeding: 5, 9, 13 pounds of seed per acre.

In summarizing the results of these experiments, significant differences in tonnage yields or sucrose percentage were not obtained except in the low seeding rates of experiment three where stands were not sufficient. Beets grown as doubles, regular 10-inch spacing, averaged approximately 50 percent as large as beets grown as singles, while those grown as doubles in hills 20 inches apart were comparable to beets grown singly 10 inches apart. In hills of three, spaced 20 inches apart, the beets were approximately two-thirds as large as those grown singly 10 inches apart. Although hand-blocking with 10 inch spacing did give approximately as good tonnage yields as the conventional single beet method, the beets were more numerous, much smaller individually and difficult to harvest. Increasing the spacing between hills to 20 inches alleviated these difficulties and gave tonnage yields comparable to single beet spacing.

These results, although not entirely conclusive, demonstrate that, experimentally at least, beets can be grown in hills approximately 20 inches apart, which suggests the possibility of cross cultivation, with a minimum of hand work on hills that contain in excess of 2 or 3 beets. The method, aside from affecting a vast saving in thinning costs, should have merit in reducing the cost of weed control during the growing season.

THE EFFECT OF BOLTING ON SUGAR BEET PRODUCTION

F. G. Larmer, Division of Sugar Plant Investigations, Bureau of Plant Industry, U.S.D.A.
(Read by Title)

The characteristic of some sugar beets to produce aerial stems bearing flowers and seeds during growth the first season has been commonly termed "bolting." Bolting beets are common in winter-planted fields in Central California, especially in the domestically-produced, disease-resistant strains

of sugar beets. Because of genetic variability in respect to the annual habit, bolters are readily classed as early or fast bolters, intermediate, and late or slow bolters, depending upon the age of the plant at the beginning of seed stalk development.

A seasonal study of the influence which bolting has on root development has shown root weight at harvest to be inversely proportional to the age of the plant at the initiation of seed stalk development. Root weight of early and intermediate bolters remained approximately constant after fertilization, the plants becoming chlorotic and showing evidence of decadence after the seed matured. Indications are that late bolting beets are more vigorous individuals than non-bolting plants, the root weight being greater at the beginning of seed stalk development. This may be true of all bolters but was not determined for the early and intermediate classes.

Intermediate bolting has a pronounced competitive effect on adjacent beets during the period of rapid vegetative growth accompanying seed stalk development. Beets adjacent to early bolters seemingly overcome this competitive influence after decadence of the bolter occurs, while beets adjacent to late bolters apparently are well established before bolting takes place.

A significant lowering of the sucrose percent was recorded during seed stalk development in all classes of bolters studied. This disparity gradually disappeared with cessation of vegetative growth and maturing of seed. Significant differences in apparent purity coefficients were not observed although the purity coefficients were at all times slightly lower in roots from bolting plants.

Cutting the seed stalks 6 to 8 inches above the crowns of intermediate bolters at flowering time had a detrimental effect on the quality of the roots. Thirty-nine percent of the beets succumbed to this treatment, with root decay causing a loss of 27.00 percent in tonnage yields. Sugar synthesis was entirely checked, the sugar content remaining approximately constant throughout the period from June 12 to August 1. However, there was an accumulation of total solids, the apparent purity coefficient being reduced from 81.15 to 50.49 percent.

CONDITION OF STORAGE AND FINAL QUALITY OF SUGAR

Hatler Gearheart, Utah-Idaho Sugar Co.
Chinook, Montana.
(Read by Title)

Tremendous losses are borne annually by the sugar beet industry because of faulty storage methods. At some factory units the loss has run to more than one hundred thousand dollars in a single year.

Beets placed in storage under ideal conditions have been observed to lose little if any in purity or to become more difficult to process. However, the loss of sugar in long storage under ideal conditions is appreciable toward spring, since nature calls the beet to put forth her leaves in the process of reproduction and she also decrees that in this process the mother beet give up sugar which was stored originally for this purpose.

There are many problems entering into the storage of sugar beets but only those affecting the beet after it is removed from the soil will be treated here.

The most common method of storing beets is in piles ranging from a few feet in width and height, to enormous piles hundreds of feet wide and long and up to 22 feet in height.

Some districts have with varied results stored beets on the grower's farms in piles ranging from one to several hundred tons. Perhaps the chief benefit derived from such methods comes in extreme frost conditions during the harvest. Certainly the loss by evaporation is greater in smaller piles than large piles because of the greater amount exposed to the sun, wind, and frost.

The most serious problem in storing and processing beets in northern climates is frost. In some sections frost occurs almost every night during the harvesting period. Because of the structure of the sugar beet, when the cells are once broken by frost, decay takes place rapidly. This is especially true when the beet is placed in any considerable sized pile or when the temperature suddenly rises above the freezing point. It is a common practice in nearly all districts to segregate for immediate processing any beets that have thus been frosted, however slightly. If a greater volume of frosted beets is received than is possible to process immediately they are usually placed in small piles containing not more than a hundred tons and being not more than eight feet high.

Next to frost in storage beets, trash, leaves, and loose dirt perhaps cause the greatest loss. It has been observed that the sugar beet when placed in large piles in storage for sugar factories goes through a sweat or curing process. They seem to generate considerable heat through this period and if the air passages are obstructed by loose dirt, etc., the problem becomes more complicated immediately. This natural generation of heat for the first few days in storage is greatly complicated by the decay of leaves and other trash. To eliminate the leaves and trash, some manufacturers of piling machinery have introduced reverse roller types of screens. These screens do not remove all the leaves and trash; the problem remains unsolved unless beets are further cleaned by hand as they pass over the conveyor belts leading to the storage piles.

Recent experiences show that wet dirt which adheres to the beet is not detrimental, as heretofore supposed by many, but is on the contrary a decided benefit to the beets while in storage.

Because of the evaporation and the deterioriation of the outside beets of a pile, it appears that a height approximating 22 feet is desirable.

The beets that are harvested dry or allowed to lay in the field exposed to the sun and wind until they are dry, are difficult to keep in satisfactory storage with a minimum of loss. This is because they go into the pile compact and shut off the air from circulation.

Beet sugar manufacturing machinery has been designed and built to handle a perfectly normal beet in the best of physical conditions, which under the most ideal conditions is a complicated process. Therefore the

storage of sugar beets to produce as nearly perfect beets at the end of the storage is the goal to be obtained. Death and natural decay set in the moment the beet is removed from the soil and any condition that will hasten this natural process is to be avoided. Frozen beets or overheated beets reduce the sugar content and purity of the juices and are to be avoided if a good quality of sugar is to be produced.

WEED INVESTIGATIONS
by the
California Agricultural Experiment Station

W. W. Robbins
Davis, California

During the past few years attention has been concentrated on chemical methods of weed control. Research has been directed to the effects, limitations, and applicability of sulphuric acid, carbon bisulphide, acid arsenical, and the chlorates. In addition, study has been made of soil sterilization methods, and a combination of treatments. Most of the results of the foregoing studies have been published, but certain more recently discovered relationships are herewith summarized.

Biological toxicity tests on four California soils show that arsenic toxicity is highest in Fresno sandy loam, intermediate in Columbia fine sandy loam, and low in Yolo clay loam and Stockton adobe clay. Variation from previous tests is explained on the basis of differences in the soil samples.

Repeated cropping of the test cultures showed that arsenic toxicity decreased in all soils until, with the seventh crop, plants in the Yolo and Stockton soils survived in cultures containing 3000 p.p.m. As_2O_3 in the air-dry soil. Differences between the Fresno and Columbia soils diminished. In the seventh run plants survived in both these soils in cultures containing 2100 p.p.m. As_2O_3.

Extensive tests involving short toxicity series in 80 California soils showed that arsenic toxicity can be correlated with texture, being high in sandy soils and low in clays. The most notable exceptions to this generalization are found among the red soils, all of which fix much arsenic and, consequently, act like heavier soils.

Arsenic dosages for soil sterilization in California should be low on coarse gritty soils having little colloidal matter.

Loams, silt loams, and clay loams from acid igneous rocks, or in highly weathered condition from other rock sources, are in the intermediate toxicity range. Also in this group will occur light soils from basic igneous and sedimentary rocks. Clays from sedimentary rocks require heavy applications of arsenic.

The extreme fixing of arsenic by these latter soils may be avoided to a degree by light annual applications of soluble arsenic or by use of arsenic trioxide. (The term "fixation" as used in this work is defined as

meaning the reduction of availability or solubility and consequently of toxicity of arsenic due principally to reaction with soil constituents.)

Heavy leaching tends to reduce the concentration of available arsenic in the soil.

Repeated cropping of chlorate-treated soils resulted in continued loss of toxicity. Toxicity to the first crop was highest in Stockton adobe clay, second in Fresno sandy loam, third in Columbia fine sandy loam, and lowest in Yolo clay loam. By the seventh crop toxicities had shifted so that Fresno sandy loam stood highest, Columbia fine sandy loam second, Yolo clay loam third, and Stockton adobe clay lowest. Although fertility governs largely the initial toxicity of chlorate in soils, some other factor controls the change in toxicity with time and cropping.

The general relation of toxicity to fertility was confirmed. Soils giving marked deviations from the expected results proved in nearly every case to have come from arid regions and consequently, to be high in total salts.

Leaching and species susceptibility are known to affect chlorate toxicity. Under ideal conditions a schedule of dosages of from 1/2 to 4 pounds per square rod should give effective control of susceptible species, the dosages between these limits being fixed by the fertility of the soil. Under average conditions and against resistant species it should be doubled.

When chlorate dosage runs above 8 pounds per square rod the cost approaches that of carbon disulfide. Considering the loss of crops and the permanent effects of the saturation of the replaceable base complex with sodium, it seems desirable to use carbon bisulphide under these conditions.

A number of chemicals, including arsenic, chlorate, and carbon bisulphide, have proved useful in weed control. In a comprehensive program all should be used, each being applied under the conditions where it is most effective and economical.

RESEARCH WORK IN DENMARK

By G. H. Siegumfeldt
Danish Sugar Beet Seed Company, Copenhagen, Denmark

Such institutions as the Danish State Experimental Stations, Danish State Plantbreeding Laboratorium, the Danish State Pathological Experimental Station, The Danish State Seed Testing Station and the Royal Danish Academy of Agriculture, all have a good standing in the international agricultural research work and within the country these institutions cooperate very closely with the practical work carried on by the common farmer.

Spread over the country are scientifically educated agriculturalists engaged with local experiments, agricultural evening courses keeping the farmers informed of anything new that might have been developed and supervising the farmers in their doings and keeping in close touch with the research

work done by the respective institutions. This is also supported by the Government.

In developing a high standard of dairy products in Denmark it became a necessity to find a nutritive fodder for the dairy cows, as owing to climatic conditions it is necessary that they be stabled during the winter months. From investigations made on this subject it soon became evident that beets were readily adapted to the Danish climatic conditions as being a field crop of great importance and economical value for the country. As the dairy products produced to some extent soon had to depend upon this crop, the Government in the beginning of the century started a special institution for research work on rootcrops.

This institution, in connection with the Danish State Experimental Stations, has, in the past years, been the backbone in our efforts to develop better varieties of beets as they carry out permanent tests and comparative trials of beet varieties every fourth year issuing a report upon their results. This is of great importance to beet breeders as only strains authorized by this Institution can be sold as first class strains in Denmark.

Fifty years ago the first sugar factory in Denmark was erected by the late C. Erhard Frederiksen, owner of some big country estates. He was also interested in breeding sugar beets which work was later continued by his son the late V. Erhard Frederiksen. Being a pupil of Professor W. Johannsen, the founder of applied heredity and creator of the theory of pure lines, V. Erhard Frederiksen of course started his sugar beet breedings upon these theories. He soon came to the conclusion that it was possible in this way to improve the sugar content and yield of sugar beets to a certain extent.

Erhard Frederiksen, as far as known, was the first to start experiments with combined crossings of sugar beets. This method is now followed by almost all sugar beet seed establishments in Europe. Unfortunately Erhard Frederiksen died when he was still very young.

This is the history of the sugar beet research work in Denmark.

Since the death of Erhard Frederiksen his theories have been carried ahead and cross-breedings to produce the commercial seed as an F_1 Generation, have shown better results than the original pure lines. Experiments with triple crossings, where three or four pure lines, through double crossing have influence on the commercial seed have also been carried out.

Some experiments with X-ray treated seed have been made but I am unable to report the results.

Fortunately, or unfortunately, we in Denmark have no waste-laying diseases on sugar beets. Fortunately for the farmers and the country, unfortunately for the technologists, who are handicapped in participating in research work regarding resistance to these diseases. We have to carry on such experiments in foreign countries, but even at that we are trying also to participate here, as in Denmark. We have excellent climate, especially suited for growing sugar beetseed.

I admire the efforts American Sugar Beet Technologists have made to save and help an industry so important to the country. In these few years they certainly have made history.

FERTILIZER PLACEMENT, RIDGE PLANTING, DISK VERSUS SHOE OPENER, MECHANICAL THINNING

E. M. Mervine, U. S. D. A.

Disk furrow openers give better stands of beets than shoe furrow openers. They justify the greater initial cost. The results are measured by germination stands as percent of inches per row containing seedlings. This year the disk furrow opener gave a 38% stand as compared to a 26% stand for the shoe opener, a 43% increase for the disk over the shoe. The average for five years' results show the stands in the disk planter to be 58.6 as compared to 50.52 for the shoe, an increase of 16%.

Machinery trials of ridge planting equipment showed incidentally that there was no significant difference in the tonnage of ridge planted vs. flat planted beets, a slight trend in favor of the flat planted. Many measurements were taken on the relative sizes of beets grown by the two methods, and a significant difference was found in that the length of the ridge planted beet was 8.488" as compared to flat planted beets, 8.17". The diameters of the ridge planted beet was smaller, 4.133", as compared to 4.283" for the flat planted beet. While these differences are significant, they are comparatively small. Germination stands by both methods are identical.

Studies this year gave results somewhat similar to those of previous years. One outstanding result was that for the first time we have some experimental data showing the definite kill of small seedlings when the fertilizer had been placed in direct contact with the seed. The results show that where phosphate had been placed at a distance from the seed, the germination stand was 51.0 and where the phosphate was placed with the seed, the stand was 25.7. In general, the indication is that better results are obtained when the phosphate is placed lower than the seed and rather close to the row. Apparently when plenty of moisture is available, there is no harm in putting the phosphate with the seed, as indicated by one test where yield was somewhat greater by this method.

Tests of experimental single seed planting equipment lead to the conclusion that it is mechanically practical to expect a rather uniform placing of the seeds in the furrow at an expected distance of one seed per inch of row. Tests have been made in field speeds ranging from .8 of a mile to 2.9 which show more misses at the higher speed but not sufficient misses to make it undesirable. In general, with ungraded seed, more small seeds are planted than the large ones which could be expected to give approximately the same number of seedlings per foot irrespective of size of seed.

SINGLE SEED SUGAR BEET PLANTING

S. W. McBirney - U.S.D.A.

Research by the Bureau of Agricultural Engineering and the Agricultural Experiment Stations of California and Colorado on the mechanical blocking and thinning of sugar beets brought to our attention a few years ago the desirability of a more uniform distribution of seedlings in the row. An ideal stand for mechanization would be one with single seedlings regularly spaced every

inch or two. However, such stands are not possible because of the multiple germed nature of sugar beet seed balls and the bunching of seedlings has been more or less attributed to multiple-germed balls.

Experimental plantings were put in very carefully by hand with one seed ball per inch of row and resulted in germination stands which were much more uniform than stands obtained with commercial planters. That is, the seedlings obtained on the hand planted plots were spread into a greater percent of the inches of the row, a condition favorable to mechanization of the thinning of the crop. Germination tests made in a seed laboratory where conditions were kept ideal showed an average of slightly less than two sprouts per seed ball on large sized, viable seed. The same seed in the field under favorable germination conditions produced an average of approximately 1.3 sprouts per seed ball. Evidently the bunching of seedlings obtained with commercial planters is largely due to the bunching of seed balls.

Following preliminary research a single row planter was built to drop single seed balls at regular intervals.

Several sets of experimental plots were put in with this small planter unit. One set of plots using a seed ball spacing of one inch which, with the seed used, gave a seeding rate of 14 to 15 pounds per acre was used for a thinning-method experiment. Others were planted at seeding rates varying from 5 to 20 pounds per acre and were used to make germination stand counts comparing the single seed planter with a commercial planter and to compare the after-thinning stands produced with the two planters. The plots were carried through the season and harvest data was taken on them.

The germination stand data on the plots with the 14 to 15 pound per acre seeding rate from all of the plantings were averaged and the results are shown in the following table where the single seed planter is compared with conventional planter and with hand planted beets.

GERMINATION STANDS
(14 to 15 pounds of seed per acre)

Planter	Seedlings per 100"	% of inches with beets	Singles per 100"
Conventional	121.7 ± 4.9	54.7 ± 1.3	14.0 ± .6
Single Seed	127.0 ± 3.3	67.2 ± 1.3	21.3 ± .8
Planted by hand	131.6 ± 7.4	72.8 ± 3.4	23.9 ± 1.2

The different plantings at the different seeding rates all showed higher percentage germination stands for the single seed planter than for the conventional planter. The average differences for each planting were significant.

The percentage stands with the single seed planter increased from 30% with the five pound seeding rate to 73% with the twenty pound seeding rate while with the conventional planter the corresponding percentages increased from 26% to 59%.

The number of singles per hundred inches was also significantly

greater with the single seed planter. The number increased from 15 singles per hundred inches at the 5 pound seeding rate to 21 for the 15 pound rate and then decreased with further increases in seeding rate. This decrease beyond the 15 pound rate is to be expected because the average number of seed balls is greater than one per inch with seeding rates over 15 pounds per acre. The maximum number of singles per hundred inches obtained with the conventional planter averaged approximately 15 at the 15 pound seeding rate. Not only did the single seed planter produce a greater number of singles but the percentage of beet-containing inches which were singles was also higher.

After-thinning stand counts showed that reasonably satisfactory stands were obtained with seeding rates as low as 5 pounds per acre with the single seed planter while the after-thinning stands obtained with the conventional planter at that seeding rate were not satisfactory.

TEN YEARS RESULTS OF FERTILIZER EXPERIMENTS ON SUGAR BEETS NEAR LOGAN, UTAH

D. W. Pittman
Utah Agricultural Experiment Station

Ten years results of using various combinations of nitrogen, phosphorus and potash fertilizer and manure on sugar beets at the Greenville Experiment Farm near Logan, Utah have shown that manure and superphosphate separately or together have given marked increases in the yield of sugar beets.

The average yields were:

No	fertilizer	10.39	tons per acre
Nitrogen	"	11.50	" "
Phosphate	"	14.46	" "
Nitrogen & Phosphate	"	15.38	" "
Manure	"	17.04	" "
Manure & Phosphate	"	18.74	" "

There has been no significant differences in the sugar content or the purity of the juice. The continued use of the manure has slightly increased the organic content of the soil and both the manure and the superphosphate has increased the available phosphate in the soil.

SOIL FERTILITY AND FERTILIZER PROBLEMS WITH SUGAR BEETS IN CALIFORNIA WITH SPECIAL REFERENCE TO THE SACRAMENTO-SAN JOAQUIN VALLEYS*

Ray A. Pendleton, U.S.D.A.

Fertilization with common commercial fertilizers for better beet yields on the mineral soils of the Sacramento Valley has not given consistent results. Consequently no general fertilizer practice can be recommended. Early response to nitrogen can usually be secured, which may permit earlier thinning but generally is not reflected in the yield.

Observations indicate that fertilizer problems on these mineral soils should be approached from the standpoint of improving the organic matter supply, improved water penetration, and better knowledge of proper fertilizer placement.

On the peat soils of California the major problem in sugar beet production concerns the low sucrose synthesis often encountered.

Excess nitrate nitrogen supply in the soil appears to be a vital factor in low sucrose synthesis. The nitrogen content of the beet is directly correlated with the sucrose content of the beet.

Phosphate and potash fertilizers added to the soil to balance the nutriment ratio have not influenced the beet development.

Tillage practices may be an important factor in controlling the soil nitrate supply.

Certain important areas in the northern part of the Delta, and minor areas throughout the peat lands show strongly acid reactions and tests indicate high returns might be expected from the use of lime.

THE EFFECT OF ROTATIONS AND MANURE UPON SUGAR BEETS

S. B. Nuckols, U. S. D. A.

At the Scottsbluff station of the Office of Western Irrigation Agriculture, a number of rotations including sugar beets as one of the crops have been conducted since 1911. These plats are ½-acre in size and one plat of each crop is grown each year.

The results from these experiments are presented in Table 1.

Continuous sugar beets for 25 years at Scottsbluff on land which has received no manure, produced during the past six years an average of 5.2 tons of beets per acre with a sugar percentage of 18.3% and apparent purity of

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*"This experimental work was conducted cooperatively by the Division of Soil Fertility and Division of Sugar Plants of the Bureau of Plant Industry, U.S. Department of Agriculture, and the University of California, Agricultural Experiment Station."

juice 93.4% with indicated available sugar per acre yield of 1774 pounds.

Five rotations which included corn, oats, wheat, potatoes with sugar beets in 2 or 3-year rotations, without any manure applications, produced 7.6 tons of beets per acre, which had a sucrose percentage of 17.9% and an apparent purity of juice of 93.1% and a yield of 2514 pounds of indicated available sugar per acre.

Four short rotations which included legumes but were not manured produced an average of 13.2 tons of beets per acre during the past six years. These beets had a sucrose percentage of 17.3%, with an apparent purity of juice of 90.8% and an indicated available sugar per acre yield of 4076 pounds. These all are sweet clover rotations.

There were 6 rotations not manured which were 4 years in length (2 with alfalfa and 4 with sweet clover). These rotations had an average yield of 14.2 tons of roots per acre which were 16.5% in sucrose percentage and 90.3% apparent purity in juice. Their yield of indicated available sugar per acre was 4224 pounds.

Four rotations which are 6 years in length not manured and have three years of alfalfa were grown, and the yield of sugar beets is 13.5 tons per acre, sucrose percentage 15.8% and apparent purity of juice 89.5% which indicates 3800 pounds of available sugar per acre.

At Scottsbluff, there are 5 rotations which are duplicated with the exception of one series not being manured at any time and the other series receives 12 tons of barnyard manure per acre before each beet crop. The manures produced an average yield of beets 16.5 tons per acre and the unmanured plats yield 9.7 tons which is a gain of 6.8 tons of beets per acre for the use of manure. The sucrose percentage of the beets from the manure plats average 16.4% and the apparent purity of juice is 89.9% while that from the untreated plats is 16.9% sucrose percentage and 91.5% purity of juice. Manuring produces 1915 more pounds of indicated available sugar per acre as the yield from manured plats is 4835 pounds per acre and, from the unmanured plats is 2920 pounds.

In the use of sweet clover in sugar beet rotations there is no very great advantage from planting sweet clover with a grain crop and plowing the land for sugar beets the following year. Pasturing the sweet clover for a full year gives increased returns. Pasturing of alfalfa for a full year before planting sugar beets is also advantageous. The plowing under of a heavy crop of spring growth of sweet clover for potatoes and following with sugar beets has been very successful.

A brief summary of these data shows that the indicated available sugar per acre presents the most reliable method of comparison of the value of the rotations. Continuous beets with only 1774 pounds of indicated available sugar per acre is a very unprofitable rotation. The yield of 2661 pounds of indicated available sugar from cash crop rotations is likewise unprofitable. The increase of the three other groups of rotations over the two mentioned heretofore gives sufficient evidence for the recommendation of these practices.

Table No. 1—THE EFFECT OF CROP ROTATION, MANURE AND LEGUMES UPON SUGAR BEETS, SCOTTSBLUFF, NEBRASKA
1930 to 1935

	Continuous beets for 25 years	Cash Crop Rotations	Rotations including legume crops	Cash Crop rotations with manure	Rotations with legumes and manure
Tons of beets per acre	5.2	8.0	13.7	16.6	16.5
Percent Sucrose	18.3	17.9	16.5	17.0	15.6
Apparent Purity Percent	93.2	92.9	90.2	90.6	88.9
Gross Sugar Per Acre, Pounds	1903	2864	4521	5644	5148
Indicated Available Sugar Per Acre	1774	2661	4078	5113	4577

Table No. 2—THE EFFECT OF CATTLE, SHEEP, AND HORSE MANURES UPON SUGAR BEETS: WHERE THE MANURES ARE APPLIED AT THE RATES OF 6, 12, 18, and 24 TONS PER ACRE.

Tons of Manure Per Acre	Harvested beets per acre	Tons of Beets per acre	Percent Sucrose	Apparent Purity Percent	Gross Sugar Per acre Pounds	Indicated Available Sugar per Acre, Pounds
None	20740	16.40	17.29	89.13	5671	5055
6-of cow 1 year old	21583	18.51	16.75	89.49	6201	5549
6-of sheep 1 yr. old	22423	18.94	16.94	89.25	6417	5727
6-of horse 1 yr. old	21303	18.54	16.95	88.36	6285	5553
6-of cow	20867	18.54	16.88	88.10	6259	5514
6-of sheep	21826	18.57	16.76	89.01	6225	5541
6-of horse	21521	18.33	17.04	88.81	6247	5548
12-of cow	21501	20.15	16.59	87.89	6686	5876
12-of sheep	21367	19.91	16.56	87.46	6594	5767
12-of horse	20982	18.82	17.01	88.55	6403	5670
18-of cow	21163	19.65	15.99	86.97	6284	5465
18-of sheep	21351	20.18	16.35	87.31	6599	5762
18-of horse	21399	20.08	16.39	87.87	6582	5784
24-of cow	20014	20.98	15.88	86.10	6377	5491
24-of sheep	20486	20.20	16.09	87.64	6500	5697
24-of horse	20347	19.56	16.37	87.53	6404	5605

Note: All manures are applied at the above rates calculated upon a 50 percent moisture content. There are 5 replications of each treatment.

Table No. 3—EFFECT OF VARIOUS RATES OF APPLICATION OF COW MANURE UPON SUGAR BEETS. WITH THE ADDITION OF 150 POUNDS SUPER PHOSPHATE TO ONE HALF OF THE PLATS--1936-1937 RESULTS AT TORRINGTON, WYOMING.

Treatments		Harvested Beets	Tons of Beets	Percent	Gross Sugar	Apparent purity	Indicated Available Sugar per Acre
Manure Tons	Phosphate Pounds	Per Acre	Per Acre	Sucrose	per Acre	Percent	
0	0	15700	8.9	16.8	2990	82.1	2455
0	150	19823	12.1	17.2	4162	87.0	3621
6	0	19482	13.4	16.9	4529	80.9	3664
6	150	20907	15.4	16.6	5113	84.6	4326
12	0	19925	14.4	17.0	4896	85.7	4196
12	150	20555	15.1	17.0	5134	81.5	4184
18	0	20378	15.3	16.5	5049	85.5	4317
18	150	19804	15.8	15.8	4993	82.6	4124
24	0	20506	16.1	15.9	5120	81.4	4168
24	150	20363	15.8	15.7	4961	83.0	4118

Note: All manures are applied at the above rates calculated upon a 50 percent moisture content. There are 5 replications of each treatment.

SUMMARY

1. As a whole the use of manure and legumes in the rotations have indicated increasement of yields of sugar beets and some decline in sucrose percentage but the yield increase has been so much greater than the sucrose percentage decline that profitable use of manure and legumes is usually indicated by the additional indicated available sugar per acre.

2. Excessive amounts of manure have not been profitably used if both use of manure and land is considered. Twelve tons per acre usually produces near maximum returns and 6 tons per acre produces the greatest gain per ton of manure used.

3. On phosphate deficient land less manure is needed if phosphate is added.

4. The sugar beet crop responds readily to the direct application of manure.

SOME DATA ON RARE ELEMENTS APPLIED TO BEETS IN THE FERTILIZER

H. D. Brown - Canada and Dominion Sugar Co.

A diseased condition of an agricultural crop has often been the stimulus to discover a deficiency in the nourishment of the plant. The crop is in a diseased condition because of some pathogene at work in the tissues, but that pathogene is very often there because of some faulty soil condition.

Many, if not most, of the plant diseases are only of economic importance because the nourishment of the plant is at fault. Very few plants develop without being in contact with sufficient number of disease spores to give them each and every wilt, blight and rot that is known to that plant. Our soil, with its decaying organic matter carries the spores of almost every known plant disease.

We have been struggling with seedling diseases of sugar beets, isolating Rhizoctonia, Phoma or Fusarium, and trying seed treatments as dusts, sprays, soakings, but in the end I can see Blackroot mainly as the result of certain physical conditions of the soil, where excess moisture, often accentuated by cold weather, puts the seedling in a condition that the ever-present fungi can easily invade it. True there are more pathogenes near the seedling when clover stems or alfalfa roots are decaying among the seedlings. Previous crop is also a big factor in the incidence of disease. It is also true that a low phosphate level is conducive to seedling diseases and we do not know how much is nutritional and how much is physical in relation to the plant infection. We do know that when the physical condition of the soil is good and the nutritional elements are present in adequate amounts, there is little tendency to plant disease.

The recognition of these facts has in recent years brought into being the term "deficiency symptoms" and this is now the "magic key" to unlock the door upon "cause and cure." Potash deficiencies, Nitrogen deficiencies, Phosphate deficiencies have had their day, and most agriculturists are on the lookout for these "rule of thumb" indications. They have been a great aid to healthier plant growth. They are easily corrected when diagnosed and have been a great aid to healthier crops.

More recently we have been made aware of the "rare elements" in plants and the evidence is accumulating that these substances, long known as present in plants in minute quantities, are essential to their normal growth. Applications of very small quantities can obviate definite plant abnormalities and diseases. Thus we have plant diseases related to Manganese deficiency, Magnesium deficiency, or lack of Copper, Boron, Iron, etc. In sugar beets the deficiency of a "rare element," or its effect upon preventing a disease, has been established in the case of "Heart Rot."

It was only in 1931 that Brandenburg demonstrated clearly that Boron deficiency occurs in the field and is the underlying cause of "heart rot" or "dry rot" in sugar beets. Already fertilizer companies are including Boron in their products. We have to guard against the tendency to think "rare elements" are a "cure all" and able to do more than they really can. "Facts about Sugar" published a report of Dr. Schmidt's work in Germany back in the February 1933 issue, and Mr. Lee Van Derlinder has given publicity to "Rare Metals in Soils" in articles of "Western Irrigation" and "New Agriculture." The most complete work on Boron and Plants of which I know has been published in England. "Boron and Plant Life" by the Boron Agr. Bureau in January 1936; "Developments in the Application of Boron in Agriculture and Horticulture" in October 1937, and "Boron in Agriculture", as Research Bulletin No. 5 of the "West of Scotland Agricultural College," in September 1937 gives a very complete picture of our knowledge to date.

In Ontario during the 1933, 1934 seasons we found some cases of "Heart Rot" of sugar beets in the alkaline soils. In 1935 we put out a preliminary

test with boracic acid on our field near Wallaceburg. The boracic acid was mixed with the seed and put in with a Planet Junior Seeder on a soil of pH 7.8, with 160 p.p.m. of available Phosphate (medium) and 35 p.p.m. of readily soluble Potash (low). The beets did not show "Heart Rot" but there was a very marked stimulus to plant growth. Our results were:-

Borax plot - 89% Stand; 10.05 tons; 16.0% sugar; 88.4% purity; 3216 lbs. per acre

Non " " - 89% " 8.60 " 16.3% " 87.8% " 3015 " " "

Magnesium treatments, as dolomitic limestone applied in the fall, compared to Calcium lime applications, failed to show any improvement over non-treated areas, on various farms. Our typical soil, called "Brookston" has upward of 1000 p.p.m. of exchangeable magnesium, with from 5 to 10 times as much exchangeable Calcium. Very few of our soils go below 500 p.p.m. for Magnesium (Stoenkamp methods).

In 1936 similar treatments of Boron gave comparable results on the Clyde soils of high alkalinity-

With Boron 11.89 tons; 14.7% sugar; 87.2% purity; 3502 lbs. per acre
No Boron 10.83 " 14.9% " 85.0% " 3235 " " "

On the Thames Clay, a soil type bordering our rivers and a Marl type near Lake Huron, we found a marked lowering of the stand of seedlings from a 2-12-6 fertilizer including Boron, which had been made up by the Canadian Fertilizer Company. The fertilizer was applied with the seed at 250# per acre, and though supposed to carry only 10 lbs. of Borax per acre, it cut the stand 12% in a moderately dry spring.

In 1937 we had adequate rainfall to disseminate the fertilizer and too much rainfall in most of our territory. We made up several tons of 2-16-6 including 5 lbs. of Borax in each 125 lb. bag of fertilizer. We found no injury to stand when applied with the seed at 2 bags per acre. We also made up our 2-16-6 fertilizer with similar quantities of Manganese Sulphate, Copper Sulphate, and Sodium Sulphate. The experiments were scattered throughout the territory on various soil types, and the series included two special fertilizer materials claimed to be superior because of the "rare elements" they contained.

Peters' All-N-One fertilizer is advertised by its bag with practically every known element and reads like a "Mendeljeff's Table" from Helium to Uranium. These claims are made on the basis of the "coal" content, and coal being of plant origin has traces of every element found in plants. This product came on the market and we wished some data on its performance.

Mineral Colloids Limited, has established an agency for selling mineral colloids in Canada, and is sparing no expense in putting the product in the hands of our farmers as a "super" fertilizer with all the advantages of "mineralization, colloidal properties, electrolytic action and even vitamins are brought into the arguments in its favour.

We applied these two "rare element" fertilizers alongside the 2-16-6 mixtures at the same rates. All the plots were seeded at one time and received the same care throughout the growing season. Unfortunately some of the districts, where the tests were placed, had an almost complete loss of

crop due to flooding, but enough good crops were harvested to give significant results. Duplicate 1/100 acre plots were dug by hand on each treatment and 6 sugar tests made per plot. The following were the results:

Treatment	Stand	Tonnage	Sugar	Purity of Juice	Recoverable Sug. per Ac.
Data on 3 Farms Using Sodium Sulphate in the Fertilizer					
Boron in 2-16-6	86.3	10.75	15.2	85.5	2770
Sodium in 2-16-6	85.6	10.19	15.1	84.8	2551
2-16-6 Alone	83.6	10.07	14.8	85.1	2501
Data on 3 Farms Using Mineral Colloids as a Fertilizer					
Boron in 2-16-6	77.0	10.79	14.6	84.9	2612
Mineral Colloids	75.6	8.54	14.5	85.2	2044
2-16-6 Alone	71.3	10.18	14.2	83.7	2382
Data on 5 Farms Using Boron, Manganese, Copper, etc. in the Fertilizer					
Boron in 2-16-6	81.8	10.63	14.62	85.3	2609
Sodium in 2-16-6		(10.19)			
Manganese in 2-16-6	81.2	9.71	14.54	85.4	2366
Copper in 2-16-6	78.8	9.52	14.72	85.4	2339
2-16-6 Alone	77.0	9.95	14.14	84.7	2355
Peters' All-N-One	80.8	9.01	14.24	84.8	2135
Mineral Colloids		(8.54)			
Diff. for Significance	5.6	.64	.60	1.2	206
Significant Treatments	none	Boron above Peters' below Min.Coll. "	none	none	Boron above Peters' below

It is apparent that Sodium, Manganese and Copper Sulphate had only a slight effect upon the beet crop and showed no significant gain.

Boron did increase the yield significantly in these tests as to tonnage, but not in sugar or purity of juice.

The Peters' All-N-One fertilizer and Mineral Colloids were significantly below the standard 2-16-6 as to tonnage without having any significant effect upon other factors.

SUMMARY OF RESULTS OF FERTILIZER TESTS CONDUCTED FOR THE LAST TEN YEARS AT THE DOMINION EXPERIMENTAL STATION LETHBRIDGE, ALBERTA, CANADA

A. E. Palmer, Dominion Experiment Station

Tests have been made with Phosphatic Nitrogenous and Potassic fertilizers on irrigated sugar beets since 1927. Phosphates, both triple-super and ammonium phosphates have increased yields in every test and on almost every individual plot where they have been applied at the time of seeding. Nitrogen applied at time of seeding has increased yields in most trials but not always and the yield increases usually have not been as great as have been secured with phosphates.

Potassium has not given significant increases on these glacial soils which have a relatively high but not injurious amounts of water soluble salts, principally sulphates of calcium, sodium and magnesium with some potassium.

Ammonium phosphate has given better response than Triple-sugar phosphate in comparative tests and is used extensively by farmers.

Applications of 60 to 100 pounds of Triple-super phosphate or Ammonium phosphate directly with the seed has depressed germination and early growth when there was a deficiency of moisture but the use of a drill shoe that places no more than 20% of the fertilizer with the seed and the balance in bands about 3/4 inch from the seed on each side has been definitely satisfactory and is used over the entire district for field plantings.

Applying fertilizer with a grain drill before seeding or side applications during the growth period, has not been promising in the few tests made with these methods, but plowing phosphates under with barnyard or green manure in the fall preceding planting has given indications of profitable increases in yields.

In rates of Application tests, yield increases have been indicated with increased amounts of ammonium phosphate up to 200 pounds per acre applied near the seed, but greater yields secured with applications exceeding 100 pounds have not been considered sufficient to justify using higher rates. Farmers are using 60 to 100 pounds per acre and almost all fields have phosphate applied at time of seeding.

It is thought that the almost invariable increase in production secured from the application of a soluble phosphate at time of seeding is associated with the depressed organic activity in the soil during the cool spring period and the resultant slowness with which fixed phosphorous is made available to plants.

SUMMARY OF 1937 FERTILIZER TESTS ON BEETS IN MONTANA

Jesse R. Green, Assistant Chemist
Montana Agricultural Experiment Station

Increased yield shown in the accompanying chart is the average increase found in the respective tests. The data indicate that there was no response to boron, copper, manganese, zinc or iodine. That is, when these elements were added to treble superphosphate there was no increase over fertilization with phosphate alone, as will be seen by comparing test No. 2 with tests 4 and 5. With other soils and other amounts of these elements the results might have been different.

In the case of complete fertilizer No. 6, nitrogen failed to show any beneficial results. Only 150 pounds of a 4-16-4 fertilizer was used. This is a very small amount of nitrogen and the writer believes it to have been lost by early irrigation. Symptoms of nitrogen deficiency were evident in all fields throughout the summer.

A very poor response was shown in the three tests with H_3PO_4 in irrigation water. The beets were 6 to 8 weeks old at the time of fertiliza-

tion. An earlier treatment may have been more beneficial.

Three tests with bone meal showed a slight improvement of the crop. Three tests with raw rock phosphate caused no increase. The actual data show a negative increase. Tests with raw rock and some of the T. V. A. phosphates on other crops show that insoluble phosphates have little, if any, value as fertilizers under Montana conditions.

Fertilizers 1 to 7, containing treble superphosphate of H_3PO_4, gave consistently good results. There were in all, 38 tests with these fertilizers. The increase ran from 3,274 to 5,675 pounds. The average sugar content of the beets from these tests is a little over 17 percent. In the tests with phosphoric acid in irrigation water, raw rock, and bone meal, all of which gave poor increases in yield, the average sugar content was about 1 percent lower.

Method of Applying Fertilizers

Results of fertilizer tests reported in the summary were obtained this year in Yellowstone and Carbon Counties of Montana. Applications of fertilizer were made with a small drill constructed especially for testing fertilizers. This year the drill was equipped with a tank and manifold to distribute liquid fertilizers into the furrows opened by the discs. In one series of tests liquid phosphoric acid was diluted to 30 or 40 times its original volume with water and put into the drill furrows.

With all fertilizers the tests consisted of strips one rod wide applied just ahead of the planter. The fertilizers used are listed on the chart. At digging time two samples consisting of 30 feet portions of two adjacent rows were taken from the center of each of the strips making a total of 120 feet of row. The beets were cleaned, topped, counted and weighed. Fifteen average beets were selected from each test for the sugar determinations.

The fertilized strips were adjacent to each other and the check strips were on each side of the entire series of tests. The two fields on which results with bone meal are reported were being fertilized by the owner at the time our tests were made.

Only three tests were made with phosphoric acid in irrigation water. Water was directed into five furrows so as to irrigate four rows from both sides. A bucket delivered a small stream of dilute phosphoric acid into the head ditch. The length of the rows was first measured, and as the water progressed the delivery of the acid was adjusted so that the required amount of fertilizer was applied. When the water reached the end of the rows it was turned off and allowed to settle. It was again turned on and allowed to run through the row. The second time no acid was added.

For more detailed discussion of the methods used and results see the 1937 report of the phosphate investigation.

Table 14—Average of Fortilizer Tests on Beets

Test Numbers	Fertilizers and method of application	Number of tests	Stand	Size per beet	Sugar	Yield per acre	Increase per acre
			PERCENT	POUNDS	PERCENT	POUNDS	POUNDS
	CHECKS	16	96	0.95	16.8	23,523	
1	Liquid phosphoric acid diluted and drilled in as other fertilizers at the rate of 40-50 pounds treble superphosphate	6	102	1.13	17.8	29,314	5,675
2	Regular treble superphosphate at rate of 125 pounds per acre	8	95	1.16	17.0	29,610	4,449
3	Fine granular treble superphosphate at the rate of 125 pounds per acre	4	98	0.99	17.7	25,079	4,578
4	125 pounds of regular treble superphosphate and 10 pounds borax per acre	5	97	0.99	17.4	24,803	3,274
5	125 pounds regular treble superphosphate 8 pounds copper sulfate, 10 pounds manganese sulfate, 8 pounds zinc sulfate, and 0.15 pounds iodine per acre	5	97	0.99	17.1	25,341	3,812
6	150 pounds complete fertilizer, 4-16-4	5	96	1.02	17.5	25,431	3,902
7	125 pounds treble superphosphate containing some free phosphoric acid	5	97	1.08	17.6	25,570	4,041
10	400 pounds raw rock phosphate	3	86	1.15	16.1	25,010	-1,123
**	85-100 pounds of bone meal applied by owner with seed	3	88	0.89	16.2	20,106	2,204
11	phosphoric acid in irrigation water at rate of 125 pounds of treble superphosphate per acre	3	103	1.11	15.7	29,196	2,354

FEEDING SUGAR BEET BY-PRODUCTS

E. J. Maynard - Maynard Brokerage Company, Billings, Montana

The sugar beet crop is a dual purpose crop. In addition to sugar it provides by-products which have been largely responsible for the development of a successful livestock feeding industry and greatly increased fertility in this intermountain country.

These beet by-products represent an integral part of the crop and the returns in form of added fertility for the farm and meat, wool or milk for market should be more clearly established and counted in if the entire value of the crop is to be recognized and fully appreciated. Recent findings have indicated added values for these beet by-products when conserved properly and used with proper mineral supplements.

With present harvesting and feeding methods beet tops suffer tremendous losses in feeding value from topping time on. We have rather definite indications that the use of certain minerals such as calcium carbonate, lime cake or chalk tends to improve their feeding value. Siloing of tops reduces their oxalic acid content to a mere trace. All beet by-products, tops, pulp and molasses are very deficient in phosphorus and in livestock rations containing a large proportion of beet by-products the use of a phosphorus supplement will greatly increase their nutritive value.

In one experiment at the Utah Agricultural Experiment Station the addition of such a supplement to a pulp, molasses and alfalfa ration actually doubled gains secured on cattle and cut costs of gain in half.

Wet beet pulp has for years been the foundational cheap and efficient feed that has made it possible for intermountain feeders to compete successfully with the corn belt. Today the demand for pulp has become so strong that the average beet grower no longer has sufficient in his allottment to depend on it alone for cheap gains. We need to develop a new standard beet by-product ration based on acre yields of beet by-products and including crops suitable for each individual beet grower's use.

By-products from an average acre of sugar beets if properly conserved and fed are equal in feeding value to the entire product from an average acre of corn. Sugar beet by-products conserved and fed properly with grain and alfalfa hay will produce cheaper beef and lamb than any other ration available in the United States, not even excepting the combinations fed in the corn belt.

According to figures presented by Morrison in his 20th edition of "Feeds and Feeding," 64.9% of the dry matter in tops at topping time is digestible. Results secured by the Colorado Agricultural Experiment Station indicate that sugar beets yield 66.5% of their weight in tops containing 20% dry matter, or 19% of their weight in tops containing 70% dry matter. On either basis a 12 ton yield of beets would produce 3192 lbs. of dry matter in tops which at topping time contained, according to Morrison's figures, 2072 lbs. of net units of feeding value (t.d.n.)

A ton of alfalfa hay contains 1066 lbs. of t.d.n., a ton of barley 1574 lbs. In other words these tops from 12 tons of beets, at topping time,

contained feed nutrients equivalent to the net fattening value in 2 tons of alfalfa hay of 1.3 lbs. of barley. Similarly the feeding value in tops, at topping time, from an 18 ton yield of beets would be equivalent to that in 3 tons of alfalfa or two tons of barley.

On this basis tops at topping time actually contain more than 3 times the net feeding value available in the beet pulp produced from the same beets.

Recent tests made by Mr. D. J. Roach, Nebraska District Supt. for the Great Western Sugar Company, indicate that 22 ton beets there produced 200 lbs. of dry matter per ton of beets produced when the tops were hauled and carefully dried. Based on Morrison's figures these tops contained 2856 lbs. of t.d.n. or 130 lbs. per ton of beets produced.

There has been little improvement in conservation methods of handling tops since the industry started yet we know that tops are much more digestible than alfalfa hay and consequently more highly perishable. Under present conditions their highest feeding value is secured by using them as quickly as possible after harvest yet this plan often reduces returns by prohibiting the use of a uniformly balanced ration throughout the feeding period. Today, tops are pastured in the field or gathered into small piles and pastured, or fed in the feed lot. In some instances tops are stacked alone or with alternate layers of hay or straw and a relatively higher feeding value is secured. They are sometimes put up green as beet tops silage but being rather high in protein they are, in this form, subject to the disadvantages generally encountered in any high protein silage.

What is the answer? They might be dehydrated and ground up, even mixed with alfalfa hay and pelleted as is being done by one concern in Montana today but is such expense justified? — and if so, how could that be accomplished on the average beet growers farm? Apparently some plan must be developed that will conserve their value at a low cost and before it is largely lost and that will enable them to be combined with suitable feeds for highest returns. The problem of labor in handling must be kept in mind for the fall season is a busy time for the beet grower.

The following plan, suggested by Mr. D. J. Roach, offers one possible solution with a practical "ring." This involves the siloing of fresh green tops with corn fodder. With such a system it is estimated that on the average 160 acre farm enough feed could be produced on 115 acres to fatten 100 head of cattle for 200 days or to fatten 1400 lambs for 120 days. This would require the tops from 40 acres of beets, (17 ton yield) 15 acres of field corn, barley from 40 acres and alfalfa from 20 acres. The plan would entail harvesting the corn when mature in September and ricking it up alongside a trench silo, then cutting it into the silo with the green tops as soon as possible after the beets are topped, mixed at an approximate rate of 70% green tops and 30% corn fodder. The above mentioned crops with a normal allotment of wet pulp should produce 480,000 lbs. of dry matter, sufficient to provide 24 lbs. per head for 100 steers for 200 days. The ration would consist of 55 to 60 lbs. of the silage, 20 lbs. of wet pulp, 5 lbs. of barley and 6 lbs. of alfalfa, a complete home grown ration. The only supplement needed would be 1/10 lb of bone meal per head per day to correct the phosphorous deficiency.

SUGAR BEET SEED BY-PRODUCTS

Paul H. Clute
Western Seed Production Corporation

With the beginning of beet seed growing in New Mexico, it was found that one of the expense items in beet seed recleaning was the disposal of the refuse, or screenings, as they are called. Before we reached a very large production, this item was not alarming, but, with increased production, the cost of disposal increased rapidly. In the beginning, we had to haul all refuse out and dump it. Finally we were able to interest several farmers in using this refuse on their land. It did show some results as a fertilizer, but the objection to this practice was having volunteer beets with which to contend. Within a year's time, we realized that, even, if we could continue this practice, the farmers were not willing to take our total production of refuse. In Arizona we ran into much the same condition and only the farmers who had alkali land would take a part of the screenings, if hauled to them.

In 1936 we put a cleaning plant in the Pecos Valley and it was our contention, at that time, that the screenings could be utilized as a feed. A large number of sheep are pastured and fed there, and, we had an opportunity to test out the screenings as a sheep feed. We used the screenings with pasture feeding by putting the screenings in windrows throughout the fields in order to make feed available at all times. An accurate check of results could not be obtained on this method of feeding, but by the time lambs were put in feed lots, a gain of 24 pounds per head had been made, and, the feeder, making an estimate of the value received, maintained that this method reduced his feed bill 25 percent. The analysis of the screenings was: Moisture 6.3%; Ash 6.34%; Crude Protein 7.86%; Crude Fat 3.83%; Fiber 38.56%; Nitrogen Free Extract 36.57%.

In the Phoenix experiments screenings were used as a cattle feed. Two pens of eleven head each were fed for 70 days with the same ration, except that in one pen screenings replaced barley. At the end of the first 45 days both pens showed practically the same gain. The final results for the 70-day feeding showed a net gain per day of 2.376 pounds with screenings, and 2.942 pounds with barley. Figuring our screenings at $2.50 a ton and barley at $35.00 a ton, the cost per pound gain on screenings was $.06896 against a cost of $.07919 for the barley ration. Taking into consideration the amount of screenings fed, in comparison to barley, the screenings are equal to 45.2 percent of the value of barley in a mixed ration. It will also run 40 to 50 percent of the value of hegari. This would indicate that screenings, after processing, should be $15.80 a ton in comparison with present market prices of barley and hegari.

Screenings put through a hammer mill with 1/8" screen will absorb 18% molasses and not ball or cake. This is satisfactory as a cheap feed but carries a low protein content. In the mixed feed we wanted to bring our protein analysis up to make it marketable for dairy herds. Use was made of screenings, hegari, cotton seed meal, molasses, essential minerals and salt, with a guaranteed analysis of: Crude Protein not less than 14%; Crude Fat not less than 2.25%; Crude Fiber not more than 20%; Nitrogen Free Extract 40%.

An improved feed was made of cottonseed meal, alfalfa seed, alfalfa

meal, ground maize, screenings, molasses and kelp meal with guaranteed analysis of crude protein not less than 15%; Crude Fat not less than 2.5%; Crude Fiber not more than 9%; Nitrogen Free Extract 54%. All of these feeds have proved very satisfactory and a market has been established for the use of screenings as a dairy cattle mix. We find it difficult to maintain a guaranteed analysis on account of the variation in the analysis of screenings.

In several feed lots that were feeding hegari ensilage, cotton seed cake and meal, ground alfalfa, ground barley straw and barley, we could mix 1/3 ground screenings, ground alfalfa, ground barley straw and cotton seed meal in the feed with hegari ensilage and increase the amount fed from 15 to 20 pounds with an average increase in gain of .3 pounds per day. Reports coming back from the packing houses claim these cattle dress out above the average.

A GREENHOUSE METHOD FOR TESTING CURLY TOP RESISTANCE IN SUGAR BEETS

N. J. Giddings, Division of Sugar Plant Investigations, U. S. D. A.

Boxes 22½ inches long by 5½ inches wide and 4 3/4 or 6 3/4 inches deep were found desirable in testing the curly top resistance in sugar beets. Twelve plants per box were used in most tests. They were planted in pairs and the number of strains used in any trial was such that one strain did not always occur at the same position in the box.

Numerous curly top resistance tests gave very uniform and comparable results. The data were also found to agree with similar data secured in field trials. Reliable data were secured as to relative susceptibility to infection, period of incubation, resistance to injury, and death of diseased plants. The grouping of plants according to severity of symptoms gives important information as to degree of resistance which has been attained and uniformity of reaction among individual plants.

(Note: This subject is discussed in detail in Phytopathology Vol. 27, pp. 773-779, 1937.)

GREENHOUSE PURPOSES AND METHODS

F. V. Owen, U. S. D. A.

Greenhouse work in connection with a breeding program with sugar beets is believed valuable chiefly because of the greater intimacy which the investigator can have with his material. Speeding up the number of reproductive generations in a single year may also be important, but since this can be done by overwintering stecklings in the field it is too expensive to utilize for this purpose greenhouse space needed for more important work.

One of the greenhouse procedures which may be mentioned is the clonal

or vegetative propagation from single plants of special interest. By this method it has been possible to root and grow many plants of identical genetic constitution. Vigorous and succulent cuttings from branches of vegetative seedstalks are considered better than vegetative buds cut from the crowns of mother beets. Physiological considerations are particularly important, however, in connection with the successful production of these vegetative seedstalks. First, a vigorous seedstalk must be produced in a bolting environment, under a low temperature and long daily photoperiod, but before this seedstalk develops too far it must be thrown vegetative or semi-vegetative in a non-bolting environment, under a warm temperature and short daily photoperiod.

With cuttings of proper vigor and size, the problem of rooting them in a cutting bed is not different from the problem of rooting cuttings from many other species of plants familiar to horticulturists and gardeners. When these plants of identical genetic constitution are made available their usefulness in providing uniform genetic material for physiological and genetic problems is quite obvious. They can also be utilized in a practical plant-breeding program to excellent advantage.

GROWING OF SUGAR BEETS IN HILLS FREE FROM COMPETITION

S. B. Nuckols, U.S.D.A.

One of the difficulties, in selection of sugar beets for breeding purposes, is the obtaining of roots which have had equal growth conditions. Commercial sugar beets are normally grown in rows 20 inches apart and spread 12 inches within the rows. Very often missing hills occur which will give an advantage to beets adjacent to the missing spaces. For a number of years, the majority of the sugar beet selection work has been done by selecting beets which were completely surrounded by evenly spaced beets and attempting to avoid beets which were adjacent to missing hills. Such beets were termed normally competitive beets. Several investigators have not considered the normally competitive beet wholly accurate but it is a means of selecting beets more uniform than can be selected if no consideration is given to adjacent missing spaces in commercial plantings.

With small amounts of seed grown from isolated plants, it is sometimes, impossible to obtain a sufficient number of competitive beets, to judge accurately the value of the strain. This is due to the small amount of seed or poor germination which is often found in inbred or isolated plants.

In 1936, three men of the Office of Sugar Plants, each working separately in different field stations, attempted to grow some sugar beets free from competition so as to evaluate the productive ability of different strains of beets. S. B. Nuckols had, at this time, collected some data and prepared a manuscript which cast additional doubt upon the accuracy of the normal competitive beet method of selection. With slightly different purposes in view, the three men of this division, planted beets in hills and spaced them to a distance apart, which would either partly or totally eliminate the competitive effect of adjacent hills and also eliminate the loss of numerous plants which were previously discarded due to missing hills.

Mr. Nuckols and John Gaskill, each, used 40-inch distances between the hills in all directions while Mr. Stewart used 30-inch intervals. The harvested results were sufficiently different, from the results obtained by normal procedure of growing breeding plots, to warrant the presentation of these data upon the growing of sugar beets free from competition.

CONCLUSIONS

1. The planting of sugar beets in hills 40 inches apart is valuable in the growing of sugar beet selections for mother beets, as it enables one to produce a greater number of mother beets from a small amount of seed.

2. The beets grown in wide spacing are larger and produce more seed than competitive beets. In some instances more than 2 pounds of seed has been grown from 1 beet.

3. These large beets can be divided into four or more parts which makes possible various open pollenization crosses (the seed beets saved in 1937 average over 12 pounds in weight).

4. The beets are free from competition one with another and beets adjacent to missing spaces are not increased in size, therefore, any beets grown can be accurately judged as to weight.

5. The hill planted beets will vary more in weight than similar beets planted in the 12 x 20 inch spacing.

6. The sucrose content of hill planted beets is slightly lower than that of commercial plantings, however, the variation between strains is no greater than that for the same strains planted in 12 x 20 inches and in majority of instances, the higher sucrose percentage strains or the lower sucrose percentage strains are identical in both types of planting.

7. The hill planted beets do not produce as great a proportion of leaves in proportion to root as do the same strains in 12 x 20 inch planting.

8. As few as 30 hills of beets have been found to give a reasonably accurate estimation of the value of a strain of beets.

9. Sugar beet breeding work will be expedited by the use of this additional method of production of mother beets; however, the competitive method will continue as a necessary part of the procedure.

WIDE SPACING AS AN AID IN SELECTION

John O. Gaskill and G. W. Deming - U.S.D.A.

Thirty two strains of sugar beets, largely of leaf-spot resistant type, were grown in 1937 under conditions of normal (10" x 20") and wide (40" x 40") spacing, in adjoining areas, with 8 replications in each spacing. All data taken from the normally-spaced plots were based on fully competitive beets, but since competition was effectively eliminated by 40" x 40" arrangement, it was not necessary to consider skips in the latter set of plots.

The results for all 32 strains indicated that performance in wide spacing was closely correlated with that in normal spacing, both for weight and percent sucrose. The correlation coefficients were 0.624 and 0.779, respectively, and were highly significant.

In order to study the variability of individual beets under wide and normal spacings, individual weights and analyses were recorded for 80 roots from each of 6 representative strains, in each of the two spacings, amounting to a total of 960 roots. Coefficients of variability for percent sucrose were 10.62 and 9.59 for wide and normal spacing, respectively, indicating slightly greater variability for wide spacing. The difference, though statistically significant, was too small to be of much importance. Coefficients of variability for weight were 26.49 and 41.30 for wide and normal spacing, respectively, and the difference was found to be highly significant. On the basis of these data, approximately 24 beets would be required to make up a sample, from normal spacing, equivalent in statistical accuracy to a 10-beet sample from wide spacing.

MOTHER BEET STORAGE METHODS

John O. Gaskill, U.S.D.A.

In the fall of 1936 approximately 650 sugar-beet roots of a commercial variety were trimmed in the usual manner for mother beets and placed in crates in a root storage cellar at Fort Collins, Colorado, where they were allowed to remain for a short time. On November 23 these roots were divided by a random method into 5 identical lots, numbered from 1 to 5. Lot #1 was analyzed immediately, and lot #5 was stored in a trench silo in accordance with customary procedure. All other lots were stored in crates in the root cellar. Individual weights and analyses were made on all roots, as indicated below:

Treatment No.	Method of Storage	Date of Analysis	Aver. Wt. per Rt. (lb)	Aver. Sucro. %
1	---	Nov. 24, 1936	1.452	15.74
2	Cellar(crates)	Jan. 4, 1937	1.416	15.53
3	Cellar(crates)	Feb. 16, 1937	1.491	15.09
4	Cellar(crates)	Mar. 29, 1937	1.460	14.77
5	Silo	Mar. 29, 1937	1.477	14.68

The roots in each lot were weighed only once—i.e. on the date of analysis—but since none of the weight-differences between lots were significant, it was assumed that neither type of storage appreciably affected the weight. Then, considering percent sucrose alone, the gradual loss during storage, in the cellar, apparently was accompanied by an approximately equal loss in the silo, as indicated by the fact that the differences in percent sucrose, between treatments #4 and 5, was only 0.09—an amount which was far from significant.

Rot was not a factor in either silo or cellar; consequently, it was concluded that, under the conditions of the experiment, the cellar besides

being a convenient place in which to store small lots of roots of breeding strains, provided conditions which were equal to those in the silo, insofar as loss in sucrose was concerned. In other words, the cellar was fully as good as the silo in holding the metabolic rate at a low figure.

A CRITICAL STUDY OF FAMILY AND GROUP BREEDING METHODS FOR SUGAR BEETS

H. E. Brewbaker and B. F. McGreevy

Introductory

The Vilmorin principle of selection which was developed by Louis Leveque de Vilmorin and his father Louis de Vilmorin in connection with their studies of vegetables and sugar beets was published in a monograph in 1856. It became known as the progeny test principle since it provided for the growing and examination of the progeny of an individual as the only method for determining its value.

This principle quickly became an essential feature of the breeding methods for many crops including sugar beets. In sugar beets it is still the essential feature of much of the breeding work, particularly in Europe, as was graphically presented by Dr. G. H. Coons in the U. S. Dept. of Agriculture Yearbook of Agriculture (1).

Since it is the intention of this paper to refer frequently to various phases of the breeding work with corn, inasmuch as the two crops are similar with respect to the fact of being largely cross-pollinated, it is well to observe that the ear-to-row methods for corn are essentially similar to the family and group methods for sugar beets.

While the pure line methods of breeding were adopted for small grains at Svalof, Sweden, in 1891, it was not until after Johannsen in 1903 and 1906 conducted his famous selection experiments with beans and barley that the pure-line theory was developed. These being naturally self-pollinated crops, he showed that variation within the progeny of a single individual could not be retained, in other words, there was a complete regression back to the average in the progeny of both the plus and minus variations. It is the pure line concept which underlies the important recent advances in breeding work with many naturally cross-pollinated crops. The ear-to-row methods which were adopted for corn by early breeders have given way almost completely to pure-line methods. It is the intention in this analysis to study statistically, so far as possible, the results obtained from an extensive application of the progeny test or family and group breeding methods employed over a period of years by the research department of The Great Western Sugar Co. Without attempting to claim any undue credit or responsibility, the experiments from which these studies were made probably constitute the most extensive application of this breeding method to the sugar beet crop in America.

The statement was made by one of the foremost European beet breeders a few years ago that "a sugar beet breeder could well consider his life a

success if he was able to increase sucrose by 1 percent and at the same time maintain yielding ability." Certain it is that such would be a real accomplishment, but in this country we have seen increased yield to the extent of saving an industry in several western states through resistance to the curly top disease alone. And we are probably soon to witness, perhaps less actual contribution in the form of increased production, but no less striking similar accomplishments from varieties nearly immune to the Cercospora leaf spot. In no other important crop have the plant breeders contributed a more brilliant page to the history of improved varieties than for sugar beets in the curly top area, and for breeding strains of sugar beets resistant to leaf spot in the areas subject to this disease.

Historical Sketch of Great Western Breeding

The breeding work of The Great Western Sugar Company was started by Hans Mendelson at Edgar, Montana, in 1910.

The greater part of the breeding was carried on at Edgar, supplemented by work at Longmont under the direction of A. C. Maxson, who started the Experiment Station at that place in 1910, until 1915 when Longmont became the seat of all Great Western breeding operations, the work being under the direction of Mr. Mendelson until 1925 at which time H. W. Dahlberg, Research Manager, took over the work of Mr. Mendelson.

During this early period the source of the material used consisted of selections from commercial yield, normal and sugar types of leading European producers; strains developed at Brookings, S.D., Experiment Station; and an Elite mother stock secured from a European producer.

In the early work progeny tests based on siloed roots analyzed in the spring formed the basis for family selection. Individuals were selected from the best families on the basis of individual weight and polarization.

Groups of from a few to a hundred or more selected roots were set out for increase. These groups were based on family performance and not on the type of stock out of which the original selection was made.

The breeding work was reorganized in 1925. Since that time family performance has been determined by a fall test of an unselected population. Only desirable families have been siloed.

In the final judgment of families the performance of preceding generations is given consideration. Only lines having a consistently good performance for several generations are finally alloted a place in the breeding program.

Selection of individuals is based on the weight and sucrose % of the individual and the physical characters of the root. Selected individuals must exceed the family means for weight and % sucrose, the emphasis being placed on each depending upon the family tendencies.

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Heritable differences of selection value exist between individuals and families within a group. It may seem trite and unnecessary to prove such is the case before a group of geneticists and plant breeders. But upon this fact hinges the possibility for improvement, and we shall present

some pertinent data. The correlation of weight and % sucrose was determined for 1028 individual roots taken at random from Old Type in 1915. The stand in the field from which these beets were taken was spotted, with considerable variability in competition between individuals. An r value of -.6310 was obtained, which is somewhat larger than commonly reported for this relationship. From this population 15 individuals from the high weight, high sucrose corner were taken for a group increase and 15 others from the low weight, low sucrose corner for a similar group, both of which were grown for seed in 1916 and a mass increase from each tested in 1917. The yields obtained from the two lots were about the same but the sucrose was 1.35% higher in the progeny of the high sucrose selections. In any case the regression from the extremes, back toward the average, was rather significant.

Schneider (8) conducted a progeny test in which the descendants of a group of large and another group of small beets from the same original mother were tested for yield and sucrose. Two such comparisons were made with results as follows:

Family	Size of previous generation	Yield of Progeny in Kg per hectare	% Sucrose
171	large	40500 ± 507	20.18 ± .06
"	small	39900 ± 543	20.34 ± .06
224	large	38200 ± 634	20.19 ± .09
"	small	38800 ± 416	20.25 ± .09

The conclusion was reached that selection resulted in no change, and that it is not a question of fixed hereditary differences, but of modification resulting from the place where the beets were cultivated. The results obtained confirm Schneider's conclusions but it is doubtful if many of us would agree to this as a general conclusion based on one generation of selection, realizing, as we do, that the character of yield must be a very complex one, and that several generations of selection would be necessary to establish the value or ineffectiveness of such selection.

In 1934 two Great Western groups were made up from beets of the same family. In one case the beets were of medium weight and % sucrose while in the other they were of medium weight and relatively high % sucrose. Following are the results of performance of progeny families:

Group	No. of Families	Selected beets Wt. (g)	% Suc.	Performance of Progeny % of Check Yield	% Sucrose	Sucrose Yield
344	28	727	17.16	85.84	106.97	91.85
348	6	816	18.80	78.72	110.25	86.87
Difference			+ 1.64	- 7.12**	+ 3.28**	- 4.98**
			"t"	- 4.39	+ 3.50	- 2.95

**Sig. to P = .01 level

The differences between the progeny of the two groups are highly significant for yield, % sucrose and sucrose yield per acre. It is very important to note that the % sucrose in the progeny followed the mother selections but that the yield of roots was negatively correlated with % sucrose in the progeny in spite of the fact that the selected mothers used for Group 348 were high in both weight and % sucrose.

In a study of variation in yield within groups very significant

differences between strains were indicated, the strain variance greatly exceeding the error variance. There are commonly represented in a group several families from each of one or more mothers. We may call the several families descending from a single mother a "class." Differences between classes was found to be significant in one out of 4 groups tested, while in the other 3 significance was approached. Differences within classes were found to be very significant. Such differences would be expected to be largely conditioned by heredity, and would be expected, on the basis of their face value, to be of measurable plant breeding interest.

In this connection the correlation of various genetic and economic characters is of interest:

	r	t	Regression
Wt. and % sucrose of selected beets	- .1839**	4.20	
Wt. mother and Wt. progeny	+ .0669	1.51	
" " " % sucrose of progeny	- .0626	1.41	
% sucrose mother and Wt. of progeny	- .1565**	3.65	- .227 (% Std. for 1% Std. in % sucrose) W on S
" " " " % sucrose progeny	+ .0781	1.76	
(581 observation, 77 classes, 503 DF for r			
Yield family and yield of progeny	+ .089	0.72	
% sucrose " " suc. of progeny	.121	0.99	
(66 DF for r within groups)			
Wt. seed per plant and yield progeny	+ .1065	2.0	0.23% per ounce
" " " " " % suc. "	+ .1482	2.5	-0.12% of Std.per ounce
(261 DF for r)			
Leafspot (a and yield, Brush (1936)	- .1904**	2.7	
" " % sucrose " "	- .2666**	3.5	
(154 DF for r within groups)			
Leafspot and yield, Longmont (1937)	- .3545**	3.3	- 3.62% Std.(Y on LS)
" " % sucrose " "	- .1954**	3.1	- 0.80% " (%S on LS)
(239 DF for r within groups)			
Vigor (b (June 6) and yield,Longmont 1937	-.2099**	3.3	- 2.53 % Std. (Y on V)
" (Oct. 1) " " " "	-.0960	1.5	
" " " leafspot " "	+.1762**	2.7	

**Significant to P = .05 level

a) Leaf spot scale 1 to 10. 1 = trace, 10 = completely burned down.

b) Vigor scale 1 to 10. 1 = very vigorous, 10 = very weak

Immer (4) has shown a correlation between % sucrose and apparent purity of .7096.

The r values for weight and % sucrose of selected beets is - .1839, which is highly significant but much less than noted previously for an unselected population (- .6310). The weight of the mother was not shown to be significantly correlated with either the weight or % sucrose of the progeny. The correlation of % sucrose of mother with weight of progeny was shown to be significant but low in value (r = - .1565). This is in line with a considerable mass of evidence indicating a danger in loss of yielding ability by

selecting beets of unusually high sugar content (refer to groups 344 and 348 cited previously). From this it would seem that % sucrose should be correlated in the progeny test but while the correlation between % sucrose in the mother and family with the progeny is positive it is not significant in either case cited.

Yield in the family was not significantly correlated with yield of the progeny, however, the number of observations is small.

The weight of seed is positively correlated with yield and negatively with % sucrose in the progeny, r being barely significant for the first case and quite significant for the latter. It must be remembered in this case as well as the others cited that the mothers used were selected usually above the average in both weight and % sucrose.

As would be expected leaf spot was significantly correlated with both yield and percent sucrose, both at Brush in 1936 and Longmont in 1937. In the latter for each unit of 1 on the scale of 1 to 10 for resistance vs. susceptibility there was an increase of 3.62% yield and .80% sucrose, the percentages being of the Standard used. The most resistant strains rated as low as 1 while the susceptible Standard rated up to 8 in some plots. This extreme difference could account for 25.34% (7 x 3.62) loss in yield and 5.6% (7 x .80) loss in % sucrose.

A vigor estimate (Scale 1 = vigorous to 10 = weak) on June 6, when the plants were about to cover the row, was correlated with final yielding ability with r = - .2099, indicating a definite, although small, positive relationship between vigor at that time and yield. A later observation on Oct. 1 was undoubtedly influenced materially by leaf spot burning, the r value of - .0960 having no statistical significance. The correlation between leaf spot and vigor was + .1732 which indicates a positive lowering of the vigor rating with heavier leaf spot incidence.

Trends in Great Western Commercial 1922 to 1936

From the historical sketch given previously it was shown that before 1926 the selection was based on a test of individuals taken from a selected population. There was no progeny test estimation of the random population from each mother; only a selected lot of roots were used for this purpose. Furthermore, the selection of mothers was based on an evaluation scale which placed the major emphasis on percent sucrose.

We have charted (Fig. 1) in % of Great Western Standard a 3-year moving average the course of the performance of Great Western commercial and one of the leading normal type European commercials. Each point on the graph represents a 3 year mean including the two years previous to the year for which the point on the graph occurs. A material drop in yield, and somewhat compensatory increase in % sucrose appeared in both the Great Western and European for the 1924 and 1925 points. Following this period a material rise in yield and to some extent a consistent drop in sucrose % occurred in both varieties, the high being reached by the European variety in 1929, and by the Great Western in 1931. A rapid drop back in yield was thereafter noted for the European while the Great Western remained more or less otherwise constant. There appears to be some correlation between the performance of the two varieties for the period from 1922 to 1931 and it may be assumed that to

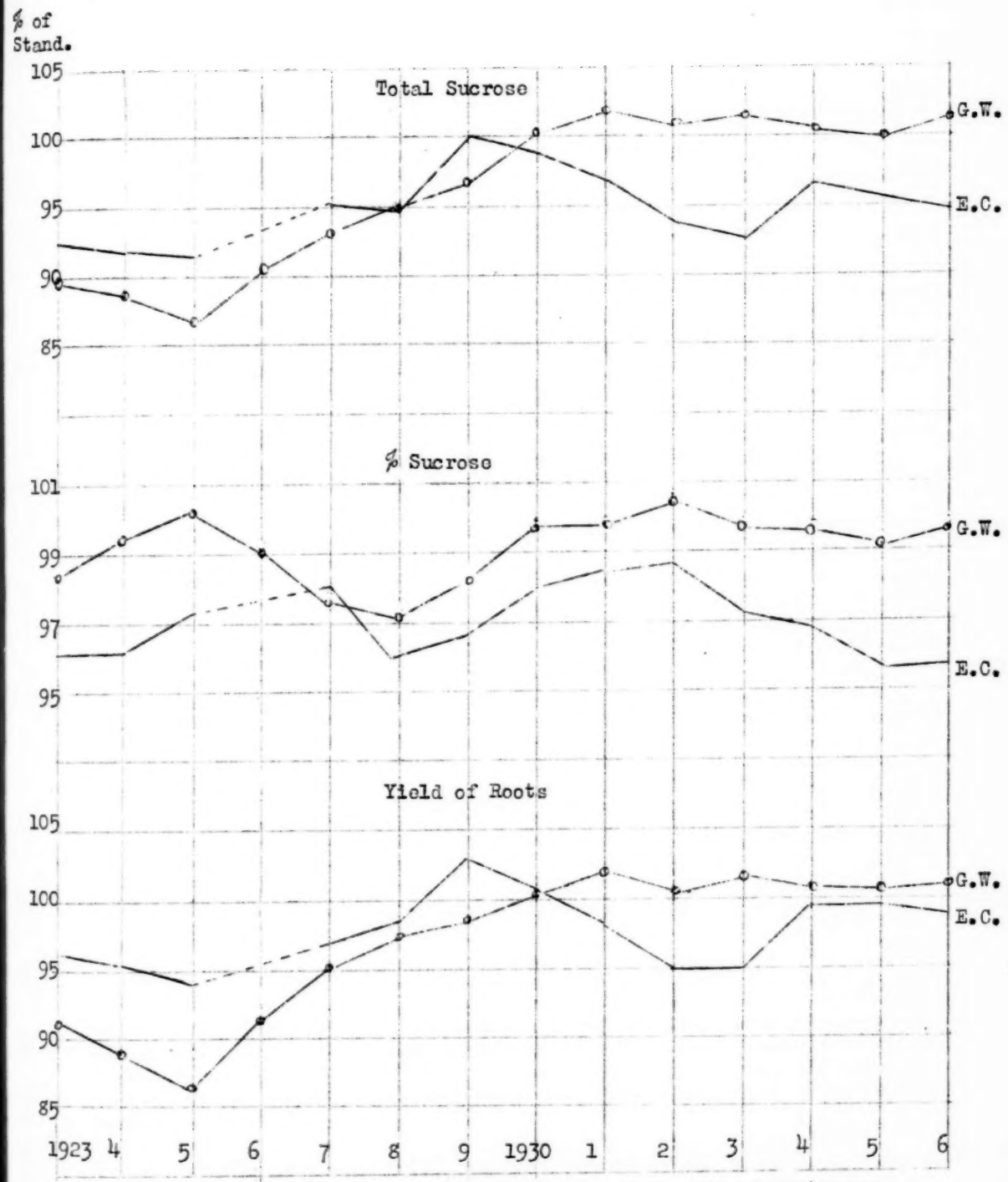

Fig. 1. Three year moving average Great Western Commercial (G.W.) and a leading European Commercial (E.C.) in % of Standard

some extent, at least the conditions under which these tests were conducted were responsible for the relative performance.

It is chiefly our concern to offer some explanation for the Great Western curve. In the first place, the drop in yield for the years 1922 to 1925 may be due in part to the unbalanced selection at that time, giving greater emphasis to sucrose percentage. Following 1925 emphasis was placed on the progeny test, which has continued to the present. The yield increase for the period 1925 - 1931 was very significant.

Following 1930-31 in spite of refinement in testing and continuous extensive selection, there has been no material change in the performance of the commercial.

It is, perhaps, worthwhile noting the apparent drop in % sucrose for 3 or 4 generations following 1925, with recovery following this depression to about the previous level from which there was little change from year to year, the average being well above the European commercial, the latter having exhibited a material and consistent regression downward in recent years in relation to the Standard.

In total sugar the curve follows the "yield" curve rather consistently, the spread between the two varieties being greater in later years, however, due to the additive effect of yield plus % sucrose.

The Great Western commercial is both a high yield and high sucrose variety. In a test in 1937 at four locations in Northern Colorado and Western Nebraska, Great Western was found to be higher in purity than all other varieties at each location, the average being 1.7 points above the average for the other varieties. In this test Great Western showed 14.0% greater sucrose yield per acre than the average of the four varieties. In addition, it possesses some degree of leaf spot resistance, or perhaps better called tolerance, since it may appear only slightly less heavily affected than the European commercials but still yields definitely higher.

The tests shown in the graph were conducted at Longmont where leaf-spot is not serious except in occasional years. If they had been conducted in Eastern Colorado where leaf spot is much more of a determining factor in yield the spread between Great Western and the European commercial would, no doubt, have been greater in recent years.

Great Western is also characterized by long smooth roots.

Discussion

The results of the progeny test or family and group methods for sugar beets, as we have attempted to analyze them, are the source of considerable satisfaction and, at the same time much concern. For it appears from the information presented, and from wide commercial tests, that the Great Western variety as now grown extensively is a real improvement over the European varieties available.

At the same time it is somewhat disconcerting to note that the curve of improvement in yield for Great Western commercial seems to have flattened out in spite of improved methods of field plot testing to isolate the more

desirable lines more efficiently. It may well be that there is still sufficient improvement, slow though it may be, taking place to justify the method. Recent groupings for leaf spot resistance indicate that a high degree of resistance may be obtained, and from the regression of yield on leaf spot presented we may confidently expect a real increase in yield resulting from increased leaf spot resistance. After this point is attained further improvement by this method appears doubtful, or at least, very slow and inefficient to an American plant breeder.

An analogy with the results obtained by the corn breeders would seem pertinent in this case. The two crops are similar in being naturally cross pollinated. The ear-to-row test used by the early corn breeders is similar to the methods as outlined here for sugar beets. We cannot go into the results obtained for corn (See Richey, 7) more than to record that it is the concensus of opinion of the corn breeders that ear-to-row methods are most effective in adapting a variety to new climatic conditions, but that the effect is not cumulative from the yield standpoint.

Perhaps the most outstanding example of progeny test selection available was conducted with corn at the Illinois Experiment Station (5). Continuous selection has been made for high and low protein and high and low oil for 38 generations. The results in 1934 after 38 generations of selection are as follows:

Strain	Analysis
High protein	23.79 % protein
Low "	10.73 " "
High oil	11.36 % oil
Low "	1.04 % oil

The efficacy of selection for the characters in question cannot be doubted. Even the more recent results show continued cumulative and positive effects of the selection. It is of vital interest from the breeding standpoint, however, that in spite of efforts used to counteract the tendency to decreased yields the yielding ability has been reduced at least 30 percent (3) in each of these selected lines. Experience with sugar beets indicate that a similar result could easily be obtained by placing first emphasis on sucrose percentage, with a corresponding probable loss in yield of roots.

It appears to be relatively simple to show improvement for one character by selection methods with group pollination, but that it becomes exceedingly more difficult, if not impossible, to show continuous improvement for a complexity of characters such as are required for corn where yield is of major importance or for sugar beets where both quality and quantity are of equal importance and where other characters such as shape of root and crown and resistance to disease are of great importance.

Pursuing the analogy with corn still further, it is sufficient to observe that ear-to-row methods were discarded several years ago and pure line methods substituted in their place. By the pure line method Hayes (2) was able to show as much increase in protein content in 4 generations without loss in yield, using the pure line method, as was obtained in the Illinois selection experiment in 15 generations. In an extensive corn yield contest in Iowa the latest published results in 1936 (6) show the average yield of hybrids, employing inbred lines, to exceed the open-pollinated entries by 30.8 percent. Farmers are not quick to purchase seed when it is so easy to

pick their own, as in corn, but at least 50 percent of all commercial cornfields in the corn belt will be planted to crossed corn in 1938 - this fact alone constituting an impressive testimony to the superiority of the varieties produced by pure line methods.

The pure line method is genetically sound. While it has been used for sugar beets for several years by the U. S. Department of Agriculture the extent of the work was necessarily very limited as compared with the accumulated experience with corn. Moreover, most of the selfing was by space isolation which is not absolute in prevention of crossing as are bagging or caging methods. The inbreeding method seems to hold much possibility for the future of improvement for the sugar beet crop.

In the popular search for new genes the wild relatives of the commercial sugar beet, as well as, the garden beet and stock beet types are not being overlooked. In the final analysis the plant breeder's task is to locate and synthesize the valuable genes into a commercial product. This task, at least, is a romantic one.

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DESIGNING VARIETY TESTS TO REVEAL THE ADAPTABILITY OF VARIETIES TO VARYING LEVELS OF FERTILITY, SPACING AND DIFFERENCES IN RATE OF MATURITY

Bion Tolman, U. S. D. A.

Proper evaluation of new varieties as they are developed is essential to carrying on a sound breeding program. Accurate and detailed comparisons between varieties become increasingly difficult as the number of varieties are increased. To save time and expense it is important that variety tests be as complete as possible.

It has been noted that varieties which have been developed in the breeding program vary widely in sugar content, yielding ability, size of top and length of season required to mature properly. Some data have also been obtained which indicates that varieties differ in their response to spacing and that this is further conditioned by soil fertility and possibly other factors more difficult to measure.

When a variety is released for commercial production it is going to be grown on a diversity of soil types and fertility levels, and it will be grown with widely differing spacings. It is desirable that varieties for commercial production have as wide an adaptability as possible. The real problem is how best to learn this in the shortest time, as important decisions must be made each year, and how best to conduct the tests where sufficient information can be obtained to make a critical comparison between varieties. Most careful attention and most critical observations can be made where as complete a test as possible is conducted on one experimental field.

With the foregoing considerations in mind, a comprehensive test including 24 varieties has been conducted during the past two years. The test included from 10 to 12 replications of each variety; covered two fertility levels, with close and wide spacing provided on each level of fertility, and harvest data were obtained on two dates, approximately one month apart, to give a measure of rate of maturity. The data obtained indicate that additional information obtained by this type of experiment is of great importance to the breeding program and commercial distribution of varieties.

FIELD PLOT METHODS WITH PARTICULAR REFERENCE TO LARGE SCALE VARIETY TESTS

F. R. Immer, University of Minnesota.

An informal discussion, no manuscript.

DECOMPOSITION LOSSES OF SUGAR FROM CUT SURFACES OF BEETS

F. R. Bachler
American Crystal Sugar Company

In such beet sugar factories where the beets are bought from the grower on a basis of their sugar content, the records show that there is invariably not only an appreciable loss in net weight of beets bought and sliced, but also a very considerable loss in the weight of sucrose paid for as compared with the weight of sucrose entering the house.

The existing differences are fairly easily traceable and can be accounted for within close limits as being due to the combination of weight losses due to shrinkage in transit and in storage, and the weight gains due to water absorption during fluming and washing. Such a control requires the keeping of daily records of the earth-tare and top-tare ratios, also frequent daily determination of the percent of water absorbed during fluming and washing.

But when sugar balance is struck there will be invariably found costly losses of sucrose, which we cannot assign to analytical errors, but must be assigned as decomposition losses. This being, no doubt, correct it is equally correct to say that a part of these losses are preventable. For instance, the beet, as a living organism, must consume some of its sucrose to satisfy its biological needs, but if the beets are temporarily stored this oxidation can become unduly high, while proper storage conditions may reduce this source of loss to a point close to the irreducible minimum and thereby could be achieved an appreciable reduction in the over-all decomposition losses.

Next to poor storage, perhaps the most potent cause of sugar losses, is that due to destruction of sucrose by inversion, starting at the point where the beet has suffered an injury. Some of these injuries are avoidable but one injury, the most serious one, that due to topping, is unavoidable, even though it could be somewhat lessened.

Topping of the beet produces an open wound of greatly varying area in which the injured and the non-injured sugar bearing cells become exposed to the deleterious effects of the air and infection by micro-organisms which bring about inversion and the destruction of the sucrose thus attacked. This sugar destroying effect grows with increasing temperature, moisture of the air, length of time and size of the wound, soon the infection spreads and, aided by the acid decomposition products which are formed at the same time, penetrates deeper and deeper into the adjoining healthy tissue, carrying in its wake further destruction of sucrose and a further increase in the organic non-sugars.

A series of carefully conducted tests were made which had as their aim the study of the decomposition losses that will occur on a light and heavily topped beet upon different length of storage. The following experimental procedure was employed:

Completely ripe, perfectly healthy and non-injured beets were selected which were grown in the same field, from the same seed, under identical soil, water and cultural conditions and which possessed, as close as it was possible

to select, the same shape and nearly the same weight. It was hoped that in meeting these conditions each individual beet would possess approximately the same invert to sucrose ratio at the time of harvest. We arranged for three groups of tests, each comprising five individual beets.

FIRST GROUP: Five beets were taken, the leaves were cut off as closely as possible at their base and care was taken not to injure the top of the beets. The beets were then weighed individually. The one which came nearest the average weight of the group was immediately completely shredded, the pulp thoroughly mixed and analyzed. The remaining four beets were stored on the concrete floor of the basement and covered lightly with a gunny sack which was kept moist. After the lapse of one week one of the beets was removed, weighed again and analyzed. After the second, third and fourth week the procedure was repeated.

SECOND GROUP: Five beets were taken. Each of the beets was topped close at the base of the green leaves. The area of the cut surface was measured. Each beet was weighed. The one whose weight came nearest to the average weight of the group was immediately shredded and analyzed. The remainder was stored alongside the beets of the first group and treated as described.

THIRD GROUP: Five beets were taken. Each of the beets were topped just below the base of the lowest leaf scar. After measuring the area of each topping surface the procedure was the same as for group one and two.

A record was kept throughout the entire storage time of the daily average temperature and moisture of the air.

METHOD OF ANALYSES: As each beet was shredded, the pulp was thoroughly mixed. Five separate normal weight portions of the pulp were weighed out and digested with distilled water for thirty minutes at 75° C. The Oxnard Sachs Le Docte factor of 179.1 ml was used. The five digestion fluids were united. In a portion was determined the immersion refractometric Brix. The remainder was clarified with Horne dry lead and polarized. For the determination of invert sugar we followed Classens procedure as follows: 110 gr. of the pulp were transferred to a 500 ml flask, 15 cc of neutral leadacetate and 2 gr of $CaCO_3$ added, then filled up to nearly the mark, mixed, placed in the hot water bath for 60 minutes, cooled, made up to 500 mark and mixed. 100 cc of the decanted juice are once more clarified with neutral lead acetate, made up to 110 ml and filtered. 100 ml of the filtrate are deleaded with Na_2CO_3, made up to 200 ml and filtered. 100 ml of the filtrate = 10 grams of original substance, are boiled with 10 ml of Fehlings solution for 2 minutes with one drop of Methylen blue solution. The still remaining blue color is then discharged by the addition of a measured volume of an 0.2% invert sugar solution. In the same manner is treated a mixture of 10 ml of Fehlings solution, 50 ml of water, 1.5 gr. of sucrose, 1 drop of methylene blue and 15 ml of the 0.2% invert sugar solution, and gradually more invert solution is added until the blue color is discharged. From the total ml of invert sugar solution used is subtracted the volume of the invert sugar solution used in the testing of the beet pulp solution. The difference, multiplied with 0.02, gives the invert sugar content in 100 grams of beet pulp.

The results obtained will be found in the accompanying table.

Table Showing the Changes in the Composition of Untared, Lightly and Heavily Topped Beets During Different Storage Times.

Beet	Item No.	Untopped Beets Free of Leaves					Beets Topped at Green Leaf Base					Beets Topped at Base of Lowest Leaf Scar				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Length of Storage in Days	1	-	7	14	21	28	-	7	14	21	28	-	7	14	21	28
Weight of Beet at start of Test, Grams	2	577	572	574	578	580	523	500	526	530	527	470	466	466	472	478
Weight of Beet at end of storage, Grams	3	577	564	562	560	555	523	492	514	512	502	470	458	455	456	455
Percent of weight lost during storage	4	-	1.40	2.09	3.11	4.31	-	1.60	2.28	3.39	4.74	-	1.71	2.36	3.38	4.81
Average storage temp. throughout test period	5	-	21.1°	22.3°	21.4°	21.7°	-	21.1°	22.3°	21.4°	21.7°	-	21.1°	22.3°	21.4°	21.7°
Average % moisture in the air during storage	6	61.2	58.3	58.7	50.3	42.1	61.2	58.3	58.7	50.3	42.1	61.2	58.3	58.7	50.3	42.1
Refractiometric Brix of juice in beet	7	21.1	21.8	21.8	22.0	22.3	21.1	21.9	22.0	21.4	22.3	21.7	22.0	22.2	22.5	22.7
% sugar in beet	8	17.75	18.30	18.10	18.05	18.70	17.90	18.45	18.65	18.20	18.35	18.55	18.75	18.60	18.65	18.25
% Purity of juice in beet	9	84.1	83.9	83.0	82.0	83.8	84.8	84.2	84.7	85.0	82.3	85.4	85.2	83.7	82.8	80.3
Invert sugar in % on Beets	10	.110	.119	.120	.137	.152	.107	.131	.157	.179	.225	.114	.185	.251	.314	.566
Ratio of invert sugar to sucrose	11	1:161.3	1:153.7	1:150.8	1:131.7	1:123.0	1:167.2	1:140.8	1:118.7	1:101.6	1:81.5	1:162.7	1:101.3	1:74.1	1:59.3	1:32.2
% increase in invert sugar ratio	12	-	4.7	6.5	18.3	23.7	-	15.7	28.9	39.2	51.2	-	37.7	54.5	63.5	80.2
pH of Digestion Juice	13	6.8	6.8	6.8	6.5	6.5	6.8	6.8	6.6	6.5	6.2	6.8	6.6	6.5	6.4	6.1
Area of Surface Injury in Square Centimeter	14	—	—	—	—	—	15.8	15.2	15.8	16.4	16.0	25.2	24.2	24.8	25.3	26.0
Appearance of Beets at end of storage	15	Perfect	Perfect	Perfect	Perfect	Perfect	Perfect	Perfect	Slightly Mouldy	Heavy Mould	Heavy Mould All Over	Perfect	Mouldy at cut	Heavy Mould at cut	Mould all over	Heavy mould all over
Appearance of tissue one inch from top	16	Healthy	Healthy	Healthy	Slightly dark		Healthy	Healthy	Slightly dark	Darkest	Quite Dark	Healthy		Slight Dark	Quite Dark	Quite Dark
Appearance of tissue two inches from top	17	Healthy	Healthy	Healthy	Healthy		Healthy	Healthy	Healthy		Slightly dark	Healthy	Healthy	Slightly dark		Quite dark

EVALUATION OF QUALITY OF GRANULATED SUGAR

J. C. Keane
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In general, the method of evaluating sugar quality or the grading of sugar as employed by various companies is essentially the same, but may vary in some of the analytical features. This discussion will deal with the general scheme employed by the Utah-Idaho Sugar Company.

The first item of consideration in evaluating sugar and the most important one is its general appearance in crystalline form. This grading is generally done by visual comparisons with arbitrarily selected sugars usually under artificial daylight illumination. This is done at our factories on each strike, and a small sample of each strike is sent to the general laboratory for visual observation. In addition, a twenty-four hour composite amounting to about three pounds of sugar is sent from each factory to the general laboratory for a detailed analysis to be made each day and the results reported as soon as possible to all factories.

These samples are placed in cellophane bags and carefully wrapped to avoid contamination in transit. The general appearance at the general laboratory is evaluated by means of a photometer; that is, a photoelectric apparatus which measures the amount of light reflected by a smooth surface of sugar using directional illumination. This instrument was designed by B. A. Brice, Physicist, Food and Drug Administration, U. S. Dept. of Agriculture and the writer. A detailed description was given in the Analytical Edition of "Industrial and Engineering Chemistry," for June 15, 1938.

The working standard of reflectance is an opaque white glass plate with a finely ground surface on which reflectance has been determined, relative to freshly prepared magnesium oxide. Thus all reflectance figures on sugars are reported in their relationship to magnesium oxide, so that if a sugar has a reflectance of 92.0% it reflects 92% as much light as MGO Surface. This system of measuring appearance assumes that which makes the sugar look good to you in the sugar bowl is the amount of light it reflects, and this is a safe assumption from the standpoint of the consumer since reflectance may be lowered by slight yellowness or grayness, or large or uneven grain size.

This objective method does away with the question of personal judgment, and gives a numerical evaluation of appearance which is a permanent record. It also furnishes a comparison not only between sugars this year, but for each succeeding year. One difficulty with an arbitrary standard is the lack of uniformity, so that when it is said that a certain factory made all A-plus sugar, this value is some what indefinite unless we know what their A-type sugar happened to be.

The percentage of ash in the sugar is determined electrometrically by means of a conductivity apparatus. While the percentage of ash may not effect the appearance, it is an important factor of quality.

The apparent color and turbidity of the solution of the sugar is determined in the same photoelectric apparatus used for reflectance measurements by means of measuring the transmittancy of the sugar solution with green and red light.

It is believed that the photoelectric method for determining the apparent color and turbidity in sugar solutions without recourse to filtration offers a simple, rapid evaluation of quality for the purpose of industrial control. The determination of apparent color in the unfiltered solutions is based on the fact that with increasing amounts of yellowish coloring matter, the ratio of green to red transmittancy, T_g/T_r, should decrease. If the suspended matter in the solution were to scatter light non-selectively, this ratio would be independent of turbidity. In sugar solutions for which a varying proportion of the scattered light is selective, however, this ratio is not entirely independent of the suspended matter, and the ratio T_g/T_r may be taken to indicate only the apparent color. The results obtained on sugars, together with the simplification gained by elimination of filtering, appear to justify its use in evaluating color quality for practical purposes. The form adopted for the apparent color index is $I_c = 100\ (1-T_g/T_r)$, since in this form $I_c = 0$ for a hypothetical sugar free from coloring matter and turbidity. and increases with increasing amounts of coloring matter. This color value could be expressed by the difference between the specific absorptive indexes for green and red light, but since the instrument scale indicates transmittancy, and since only a practical quality index for solution of constant depth and concentration is desired, it is believed there would be no advantage in using the more usual logarithmic form of expression.

The turbidity index adopted is $I_t = 100\ (1-T_r)$, which is the percent absorbency of the unfiltered sugar solution for red light. This index is practically independent of the coloring matter in solutions of white sugar, because there is virtually no light absorption in the red part of the spectrum by the small amount of coloring matter present. In this form $I_t = 0$ for a hypothetical sugar solution free from suspended matter and having a relatively small quantity of coloring matter and would increase with increasing turbidity. The importance of having the sugar low in color and turbidity is well appreciated.

The degree to which a sugar foams while being dissolved with heat is another quality consideration, and a standard method in general use is applied to each sugar for this determination.

The presence of appreciable amounts of sulphites in sugar is objectionable to certain users, so the amount present in parts per million is determined in each sample. These determinations are made daily and the results reported.

In addition to the foregoing analysis, a portion of the sugar from each factory goes to make up a weekly composite on which the following determinations are made: barley candy, bacteriological examination and screening test.

The barley candy test is one in use for many years, and consists essentially of heating sugar and water under standardized conditions to 350°F and determining the amount of color in the resulting hard candy. The color of the barley candies were determined on the photometer, using a lower concentration and less depth of solution because of the greater amount of coloring matter.

For the bacteriological examination of the sugars, the methods of the National Canners Association were used. In order to conform to the bacteriological standards set by them, the sugars must meet the following specifications:

Total Aerobic Thermophilic Spores

"For the five samples examined, there shall be a maximum of not more than 150 spores and an average of not more than 125 spores per 10 grams of sugar."

Aerobic Flat Sour Spores

"For the five samples examined, there shall be a maximum of not more than 75 spores and an average of not more than 50 spores per 10 grams of sugar."

Anaerobic Sulfide Spoilage Spores

"These shall be present in not more than two (40 percent) of the five samples and in any one sample to the extent of not more than five spores per 10 grams."

Anaerobic Thermophilic Hard Swell Spores

"These shall be present in not more than three (60 percent) of the five samples and in any one sample to the extent of not more than four (65 percent) tubes (method for testing.)

The screening test made on the weekly composite merely supplements those made on each shift at the factory and includes some additional sieves, all sieves of the control set being of U. S. Bureau of standard specification.

CERCOSPORA CONTROL BY SPRAY AND DUST

H. D. Brown
Canada and Dominion Sugar Company

The sugar beet growing area of Eastern Canada centers in the most southerly point of Canada, between Lakes Erie, St. Clair and Huron.

Cercospora infection has been severe in the factory areas in 4 years out of the past 8 years, and fairly general in 1932, 1935 and 1937. Our beets lost most of their normal leafage in August and grew an extended crown and new tufts of leaves before harvest. The sugar contents in the years of severe infection were:

1931 -	Local beets	14.4%;	outside areas	15.4%;	general average	14.76%
1932 -	" "	14.5%;	" "	15.4%;	" "	14.87%
1935 -	" "	14.9%;	" "	15.8%;	" "	15.28%
1937 -	" "	(14.9%)	" "	(16.0)	" "	(15.35)

Among the recommendations for mitigation of Cercospora infection are the following and our experience with them:

1. Deep Fall Plowing. It has had little to do with Leaf Spot occurrence since 85% of our beet fields are fall plowed regularly and only 2% is unplowed. This 2% is in rotation and plowed for other crops.

2. Crop rotation is important, and since 1933 a clause has been in our contract stating that beets are not to be planted on land that was in beets the previous year. Beets after beets is now less than 1% of our acreage and usually on part of a field altered for refencing. "Beets after beets" has proven time after time to lead to early infection and severe leaf blight. When part of a field has been in beets the previous year we have found that part brown with dead beet leaves while the rotation part was green. Unfortunately the Cercospora spreads rapidly and two weeks later the whole field is brown. Adjacent beet seed plots have also spread infection early and severely.

One of the most striking cases occurred this past season on a farm where we tried out some commercial seed varieties on a field that had been in beets the previous year. It had been in alfalfa and pasture for 20 years previously and this year averaged 13.7% sugar, while a field across the land which was in a 5 year rotation averaged 17.1% sugar when harvested at the same time.

3. Removal of Beet Tops is very important and in my opinion, the failure to do so in our local factory areas, has been a distinct contributing cause to high infection. High priced land suited to market gardening and cash crops, does not carry sufficient live stock to utilize the tops and a large proportion is consequently left to rot on the fields. We are encouraging piling, pitting, siloing and feeding, but improvement is slow. We do not know how long the spores remain viable in the soil, but it is probably several years at least. We also want data on the biologic strains and the carrying of infection on weeds or other plants.

4. Spraying beets was undertaken in 1933, when 40 gallon Massey Harris Sprayer was used with one, two and three sprayings of 4-4-40 (Bordeaux). Tonnages were increased by 1.6 tons, sugar by 1.3% and purity of juice by 3%. 1934 had a dry midsummer and the beet crop was late in developing, so that spraying was not feasible, but in 1935 the results were striking. Three sprays gave increases of 4 tons per acre, 2.3% higher sugar and 3% increase in purity of juice. A 100 gallon sprayer with 21 nozzles, 3 to a row, was used and loaned to about 25 farmers. The time taken to spray during grain harvest rush and the lack of handy water supply caused the farmers to rely on a single spray. They averaged 3/4 ton increase with .7% higher sugar, but keeping the nozzles clear was a fag.

In 1936 a power duster was used, as well as the wet spray, and equally good results were obtained. The dust was easier to apply, but the cost of materials was tripled. It was not a year of severe leaf spot and only local area beets were affected.

In 1937 excessive spring rains flooded out a considerable acreage and the stand was lessened so that Cercospora was not anticipated. Beet top growth was luxuriant, and humidity was excessive throughout August. As in 1935 many 12 ton per acre estimates turned out to be 8 ton crops due to Leaf Spot. The following are the results with a snall 2 row hand duster, costing less than $15. and using 35 pounds per acre of a copper lime dust.

1937 Results with Dusting and Spraying Sugar Beets

Harvest Date	Treatment	Wt. of Tops	Tons per Acre	Sugar%	Purity of Juice
Sept. 19th -	Dusted	1# 8 oz.	9.3	16.8	89.8
	Not sprayed	0# 13 oz.	8.0	15.6	87.4
Oct. 5th -	Dusted	1# 7½ oz.		17.1	66.7
	Not Dusted	0# 14 oz.		15.8	85.2
Oct. 15th -	Dusted 3 times		10.2 tons	16.7	87.9
	Sprayed 3 times		9.4 "	15.8	88.1
	Not Sprayed		8.4 "	15.0	86.6
Oct. 29th -	Dusted 3 times		11.05 "	16.0	84.4
	Sprayed 3 times		10.42 "	15.2	85.4
	Not Sprayed		9.33 "	14.4	83.2

Similar results were obtained on Charles Baker's farm where one spraying gave the following:

Sprayed areas	11.1 tons	per acre	- 14.6%	sugar
Not sprayed	10.5 "	" "	- 13.4%	"
Increase	.6 "	" "	- 1.2%	"

Our conclusions from these tests and previous experiences are:

1. Gains for dust and spray are quite marked in years when Cercospora occurs and in Ontario these have been severe in 3 years out of 8 years and moderate in the factory areas half the number of seasons, during recent years.

2. Dusting gives as good or better results than wet spray, and is put on with a fraction of the labor, though at present prices, the dusts cost twice as much as the materials for a wet spray.

3. Three dustings take about 100 lbs. of material per acre and costs the equivalent of 2/3 of a ton of beets or 1⅓% more sugar in the average crop yield.

4. The wet spray is impracticable under most local conditions due to
   (a) Lack of adequate and handy water supply on many farms.
   (b) Rush of grain harvesting and threshing when spraying should be done.
   (c) Time taken to clean out the nozzles which plug with lime and pipe flakes.
   (d) Necessity of spraying before infection is evident, to act as a preventative when the infections are not regular.
   (e) The cost of machines and materials relative to the price received for beets.
   (f) Repetitions of treatment necessary to protect the crop through a 6 week period when rain may wash off most of the spray at any time.

5. Dusting is more feasible and should be encouraged for small acreages at least, where hand equipment can be used. A cheaper material is necessary, however. Larger acreages would need to be handled by company or cooperative machines on an acre basis.

6. Humidities and crop growth in various localities should be recorded and bulletins should go along with a spray service to beet growers during the critical period, which in Ontario, is July 15th to August 30th.

ROOT-ROTS OF THE SUGAR BEET

Asa C. Maxson
Great Western Sugar Company

From the seedling stage, throughout the growing season, and, in the case of roots held for seed production, throughout the storage period, as well, sugar beets are subject to attack by root-rots.

At least 8 major forms of root-rot of the sugar beet, exclusive of the seedling rots, are recognized. These are:

1. Brown rot; caused by Rhizoctonia solani.
2. Dry canker; caused by a Rhizoctonia, possibly a strain of solani.
3. Red rot or root killer; caused by Rhizoctonia crocorum which seems to be the R. violacea of Europe.
4. Fusarium rot; caused by Fusarium sp.
5. Crown rot; more commonly a storage rot than a field rot; caused by Phoma betae.
6. Pythium rot; caused by Pythium sp.
7. Sclerotium rot; caused by Sclerotium Rolfsii
8. Phytophthora rot: caused by Phytophthora dorschleri

To this list may be added a rot which occurs in Texas and adjoining southern states and which is caused by the cotton root-rot fungus Phymatotrichum omnivorum.

DESCRIPTION OF ROTS

BROWN ROT:

The early symptoms of this rot are varied. In some cases dark brown lesions appear on the body of the root at varying distances below the surface of the ground. When one of these lesions occurs deep down on the tap-root a wilting of the leaves indicates the presence of the disease.

DRY CANKER:

The dry canker form of Rhizoctonia rot was described by Richards (1) in 1921 at which time he considered Corticium vagum, the sterile form of which is Rhizoctonia solani, the cause. In discussing the results of his studies Richards says "—— it appears from the results that this particular "strain" of C. vagum is capable of producing the type of canker and dry rot with which it is constantly associated in the field."

Portions of Richards description are given here. "The disease is first detected in the field by abnormal wilting of the leaves in the day time with partial or complete recovery at night. Later the older leaves fail to recover, turn brown and die. "—Localized browning frequently occurs in the blade and petiole—. Neither the petiole decay reported by Dugger nor the Western crown rot described by Edson have been found associated with dry canker in the field. ——The fungus has not been observed to attack the beet above the soil line. ——As the fungus eats its way from the point of entrance the outer tissue, due to killing and subsequent drying out of the cells beneath, sinks in such a manner as to produce the circular lesion with its very definite undulating

contour of alternating raised and sunken concentric rings. — The distinctive feature of the contour--is obtained usually before the fungus penetrates deeply into the tissue of the beet and before a serious rupture of the outer layer occurs. With the drying out and final cracking of this outer covering the fungus, possibly because of a better oxygen relation, eats rapidly into the beet, producing deep cankers. —— With numerous points of attack the beet by harvest time is converted into a dry, brittle shell filled with a pithy mass of host and fungous debris.

RED ROT OR ROOT KILLER:

The first indication of disease is a wilting of the leaves of beets over clearly defined areas or of individual beets scattered over the field.

The disease does not penetrate deeply into the tissue of the body of the root. The death of the plant results from the destruction of the tap-root.

Red Rot seems to be a late summer malady no cases coming under our observation before September. It has been observed in northern Colorado and is quite common in the North Platte valley in Nebraska.

FUSARIUM ROT:

Fusarium sp. seems to be constantly associated with several forms of sugar beet-rots. Some of these may be seasonal forms of the same disease, however, for the purpose of this discussion 3 forms will be considered.

Tip-rot: The name tip-rot is applied to that form of Fusarium rot in which the causal organism attacks the tap-root some distance below the surface of the ground.

Wilting of the leaves is the first indication of the disease. Upon removing the beet from the soil it will be found that the rot has destroyed the tap-root. If the beet is pulled one gets the impression that the rot has started at the tip of the root and progressed upward. A careful examination reveals the fact that the rot has developed at a point some distance below the surface of the soil and as a result the root breaks off at this point when pulled. Below this point the root remains in a normal condition.

The second form of Fusarium rot is noted in late summer usually. At this time the affected beets may be completely destroyed. It seems probable that this rot is just the advanced stage of tip-rot. Because its association with tip-rot is seldom suspected if such a connection exists it has been discussed separately. Roots affected by this disease develop the same cavities mentioned in connection with tip-rot.

The third form of Fusarium rot is constantly associated with the disease known as Black-heart.

The first symptom is yellowing of the leaves. This discoloration usually appears between the larger veins. These areas gradually become almost yellow and then turn to a dirty dark brown.

Black heart is a physiological malady induced by a lack of available

phosphate in the soil. Fusarium sp. are constantly associated with the root rot stage of Black-heart.

PYTHIUM ROT:

While the Pythium fungus has long been known as the cause of damping off of sugar beet seedlings its connection with root rots later in the season has not attracted so much attention.

Only one case of Pythium rot after beets have passed the seedling stage has been observed by the writer. This occurred on a ridge planted field near Hershey, Nebraska.

The first indication of the disease was a wilting of the leaves. This was followed by a complete collapse of the plants and a very watery rot of the roots. There seemed to be no cases of recovery.

CROWN ROT:

Wilting and death of the leaves are the first indications of this trouble. An examination of the roots of the beets reveals brownish areas on the body of the root usually not far below the crown. The rot in the field is usually soft and watery at first. In section the rotten areas are a mottled brown traversed by rather narrow, crooked lines of almost black or with scattered small, irregular blackish areas. Phoma betae is constantly associated with this type or rot. This Phoma rot has been observed as a serious field disease several times, however, it more often occurs as a storage rot in beets held for seed production.

Phoma betae is constantly associated with the physiological malady known as Heart-and-dry rot caused by a lack of Boron in the soil. Phoma seems to bear the same relation to Heart-and-dry rot that Fusarium does to Black-heart. "In the early stages of the disease the leaves may wilt during the day and recover at night. Later permanent wilting may occur and the plant is killed. Generally infection occurs near the basal part of the root and invasion progresses gradually upward involving all tissue of the root.---under field conditions the affected parenchyma at the base of the root may soften and disintegrate leaving only the vascular strands. ---Secondary or adentitious lateral roots often develop above the invaded region of the tap-root and an ill shaped, pronglike root is the result."

"Often lesions arise on the sides and sometimes near the upper part of the tap-root. Infrequently infection occurs at the tip or along the sides of lateral roots or rootlets, with subsequent invasion of the tap-root around the base of the infected lateral root or rootlet."

"The lesions vary in size and shape and sometimes the entire root is involved. The predominant external color of the lesions ranges from the mummy brown to light seal brown of Ridgeway, (1)(4) tending toward blackish brown at the center."

SCLEROTIUM ROT:

The writer has had no personal contact with this disease. For the information here given I am indebted to Dr. W. W. Robbins and L. D. Leach, the

following description is from circular 95 of the University of California.

"The most noticeable aboveground symptom of this disease is a sudden wilting of the leaves, frequently preceded, however, by an unthrifty appearance of the plant. When a diseased plant is removed from the soil, the white, silky or cottony strands (the mycelium) of the fungus can be observed on the surface of the root and in the soil nearby. The only reliable sign of this particular type of rot is the presence of small, round, white or tan or brown bodies (the sclerotia) closely resembling mustard seed. These sclerotia, produced in great abundance on the beet root and in the soil surrounding the beet, carry over the fungus from one year to another.

What can be done about it?

The final answer to this important question must come from the agronomist and the plant breeder. The answer must come from studies of seed and soil treatments; for cultural practices and cropping schemes; or from genetic studies and the production of resistant strains of sugar beets.

Work done by the research department of the Great Western Sugar Co. seems to furnish certain guide posts for future endeavor.

It is our opinion that little of practical value can be accomplished by seed and soil treatments outside of those cases where a disease is seed borne or is due to a soil deficiency as in the case of Black-heart and Heart- and Dry rot.

That there is a reasonable chance of producing resistant strains is beyond question. However, what the industry needs is immediate relief while it is waiting for the plant breeder to produce the resistant beet.

The surveys referred to furnish valuable suggestions for the cultural control of Rhizoctonia rot which is the most serious disease in the great plains area.

In the 1935 study the Coefficient of Association was employed to determine the relation of previous crops to Rhizoctonia rot. The continuous growing of sugar beets increased Rhizoctonia as the following shows.

Beets in 1935 only;	Coefficient	0.65
" " 1934, 1935;	"	0.70
" " 1933-34-35;	"	1.47
" " 1932-33-34-35;	"	1.65

The larger the coefficient the larger the percent of fields in the class, injured by Rhizoctonia.

Small grain has the opposite effect from beets upon the amount of Rhizoctonia as the following clearly shows.

Grain	1	year	of	four	preceding	1935	beet	crop	Coef.	1.24
"	2	"	"	"	"	"	"	"	"	1.36
"	3	"	"	"	"	"	"	"	"	0.42
"	4	"	"	"	"	"	"	"	"	No rot.

The data secured in the 1937 survey was of such a nature that the

method of analysis used in 1935 could not be employed.

In addition to other data reported in 1937 the estimated damage was secured. With this as a basis a study was made of the effect of previous crops upon the damage caused by Rhizoctonia. In this part of the 1937 study sugar beets, potatoes, alfalfa, sweet clover, beans, and garden truck are considered host crops. Small grain and corn are considered non-host crops.

The following indicates some interesting relations.

Damage	all cases	beets	following	host crops regardless of number	12.70%
"	"	"	"	non-host crops	6.40%
"	"	"	"	2 or more host crops	13.83%
"	"	"	"	1 only host crop	10.07%
"	"	"	"	1 only non-host crop	7.36%
"	"	"	"	2 or more non-host crops	4.40%

EFFECT OF DOWNY MILDEW ON SIZE, SUCROSE PERCENTAGE, AND PURITY OF SUGAR BEETS

By L. D. Leach
Assistant Plant Pathologist, University of California

For many years downy mildew has been recognized as a serious disease of sugar beets in the coastal regions of California during seasons when climatic conditions favored the development of the fungus. Prior to 1935 this disease was considered of minor importance in the interior valleys. During the past three seasons (1935-1937), however, serious infestations have occurred over wide areas in the lower Sacramento Valley.

Growers and sugar company officials frequently report that the yield of beets is strikingly reduced by downy mildew infestations, and some have observed that the sucrose percentage and apparent purity of beets from mildewed fields is lower than from disease-free fields --a condition that would interfere seriously with sugar extraction.

Previous to this year (1937) two attempts have been made to determine the effect of downy mildew on the size and yield of sugar beets. The results reported in table 1 show that both at Salinas in 1930 and at Davis in 1935 the indicated available sugar from infected beets was from 30 to 40 percent less than from healthy beets in the same field. In both cases the average root weight, sucrose percentage, and apparent purity were significantly lower in diseased than in healthy beets.

Table 1.---Effect of Downy Mildew on Yield of Sugar Beets

	Healthy	Diseased	Difference	Odds
A. Salinas, California, 1930				
Average Root weight, pounds	3.13	2.43	0.70	768:1
Sucrose percentage	13.5	11.5	2.0	4999:1
Purity percentage	83.8	77.3	6.5	1666:1
Relative Yield: Ind. available sugar*	100.0	61.0	39.0	
Tonnage	100.0	77.6	22.4	

Table 1, Continued.

	Healthy	Diseased	Difference	Odds
B. Davis, California, 1935				
Average root weight, pounds	2.27	1.72	0.55	62:1
Sucrose percentage	15.7	14.3	1.4	28:1
Purity percentage	87.5	85.7	1.8	33:1
Relative Yield:				
Ind. available sugar*	100.0	67.6	32.4	
Tonnage	100.0	75.8	24.2	

*Assuming 100 percent extraction

During the spring of 1937, a planting of sugar beets was made at Santa Maria, California, in cooperation with the Union Sugar Company for the purpose of determining:

(1) The effect of downy mildew on the yield of sugar beets.
(2) The relative susceptibility of some commercial varieties of sugar beets.

Ten varieties were planted in 4-row plots, 100 feet long, and replicated five times in randomized blocks.

Table 2.—Infection Rate of Downy Mildew and the Relation of Time of Infection to Average Root Weight. Planted March 5, 1937, Santa Maria, California.

Date	Days after Planting	Percentage Infection		Average root weight
		Increase	Total	Pounds
Apr. 26	52	0.42	0.42	0.72
May 11	67	0.61	1.03	0.42
May 28	84	6.02	7.05	0.51
June 11	98	6.37	13.42	0.76
June 25	112	7.60	21.02	1.10
July 10	127	2.42	23.44	1.59
July 26	143	1.51	24.95	1.83
Non-infected beets				1.35

To determine the effect of early downy mildew infection on the sucrose percentage, purity, and yield of sugar beets, samples were collected in each variety from those beets observed to be infected within 100 days after planting. In the same way, samples were taken from beets showing infection after that date and from the non-mildewed beets to represent, respectively, the late infected and healthy groups of beets.

The results, presented in table 3, show that early infected beets were less than half as large as healthy beets, whereas late infected beets were nearly normal in size. The sucrose percentage of both early and late infected beets was over 2 percent lower than that of the non-infected beets.

Table 3.—Effect of Early and Late Downy Mildew Infections on the Yield of Sugar Beets, Santa Maria, California, 1937

	Infection Observed		Average of all Beets	
	Prior to 100 days of age	Between 100 and 150 days of age	Infected	Non-Infected
Average root weight Pounds	0.647	1.316	0.98	1.348
Sucrose percentage	15.12	15.58	15.42	17.77
Purity percentage	75.65	76.29	76.10	81.92
Tare percentage	7.79	5.68	6.73	5.25
Relative Yield: Tonnage, Percent	48.0	97.6	72.6	100.0
Percent Ind.available sugar*	37.6	79.4	58.2	100.0

*Based on 100 percent extraction. Obtained by multiplying yield by sucrose percentage by purity percentage.

These results indicate that downy mildew interferes with normal production of sugar beets by reducing the average root weight and the sucrose percentage. The death of a considerable number of infected beets is still another factor that reduces productivity. The extraction of sugar is also interfered with because of the reduced percentage of purity. Infections that occur early in the life of the sugar beet appear to be considerably more serious in relation to all of these than are late infections.

The 1937 trials at Santa Maria provided an opportunity to compare the susceptibility of nine varieties of sugar beets under a moderately severe natural epidemic of downy mildew. The percentages of infection shown in table 4 indicate that Hartmann and Eagle Hill are significantly less susceptible than the other varieties tested:

Table 4.—Relative Susceptibility of Sugar Beet Varieties to Downy Mildew, Santa Maria, California. Planted March 5, 1937.

Variety	Percentage of Infection
Hartmann	15.1
Eagle Hill Brand	16.9
Hilleshog	21.5
U. S. 33	22.5
R. & G. Normal	25.6
R. & G. Old Type	26.3
U. S. 12	26.4
A-600	30.6
U. S. 14	36.3
Difference required for significance.....	2.81

STUDIES ON CURLY TOP EPIDEMIOLOGY IN SUGAR BEET FIELDS

Albert M. Murphy
U.S.D.A.

Epidemiology was studied in connection with agronomic evaluation of a series of curly top resistant sugar beet varieties. Randomized arrangement of many times replicated plots was used. Dates of planting and dates of thinning were varied and on half of the field curly top virus was introduced by extensive release of viruliferous leafhoppers in advance of the natural infestation.

Studies were also made on the relation of 8" and 20" spacing to the rate of curly top infection, yield and sucrose percentage with varieties varying in resistance as follows: a susceptible European brand; a variety of intermediate resistance, U.S. 33; and a highly resistant variety, No. 619. Under the conditions of the tests the wider spacing was relatively unfavorable for the susceptible variety; the wider spacing gave poorer results with the variety of intermediate resistance; but with the highly resistant variety the wider spacing was advantageous.

A GENERAL DISCUSSION OF THE BEET LEAFHOPPER

W. C. Cook, U.S.D.A.

The beef leafhopper, or "white fly" is a tiny insect, somewhat less than ⅛ inch long, varying from gray to greenish yellow in color. So far as we know, this insect is native to the western part of the United States and northern Mexico, where it is found breeding upon many desert weeds.

Most of the desert breeding plants of the beet leafhopper are short-lived spring annuals living in areas where the heaviest rains fall during winter and early spring. These plants mature and dry rather early, and the leafhoppers are forced to move to other green vegetation. The dispersal areas are usually cultivated and irrigated regions, where green food is available during the summer. The larger known breeding and dispersal areas are:

(1) The Central Columbia Area.
(2) The Southern Idaho Area.
(3) Utah, Nevada, and Northwestern Arizona.
(4) California.
(5) Southern Arizona.
(6) Western Texas and Southern New Mexico.

In all except the last two of these areas, the chief breeding plant is Russian Thistle. Other plants are involved to a limited extent, but extended studies and experimental control work have demonstrated that Russian thistle is a key plant.

The principal spring hosts vary widely in the different breeding grounds. Filaree is important in Oregon and Washington; native mustards in Idaho; while filaree, native plantains, and peppergrasses make possible the

breeding of spring migrants in the other areas.

The introduction of strains of sugar beets that are resistant to curly-top has gone a long way toward solving the curly-top problem so far as it relates to sugar beets. However, this is the only susceptible crop for which resistant strains are available, and curly-top attacks many other crops, including tomatoes, any varieties of beans, most curcubitaceous crops, and a large variety of ornamental plants. The resistant strains of sugar beets have proved so successful that sugar beets are now being grown in many areas where the older varieties were not able to grow successfully. This has resulted in an increase of available favorable summer hosts for the beet leafhopper, and in increased populations of leafhoppers. Further, a larger percentage of the leafhoppers bred on beets quite often carry virus than of those bred on other summer hosts. This results in the introduction of more, and probably more virulent, virus into the desert breeding grounds. This more abundant supply of virus is picked up by the leafhoppers and carried with them on their migrations, so the damage to crops other than beets may become intensified by the growing of resistant beets. For this reason the Bureau of Entomology and Plant Quarantine is carrying on control studies more intensively than before the introduction of resistant varieties of beets.

Control measures are most readily considered if divided into immediate control measure, such as crop spraying, leafhopper spraying, and the control of host plants by cultural methods, and indirect or long-time control of host plants by cultural methods, and indirect or long-time control measures which depend upon community action over a period of time for their effectiveness.

Immediate Control Measures

Although resistant varieties of sugar beets are much more resistant to curly top than are the older varieties, they are not immune, and under certain conditions it seems possible that the crop might be increased through spraying.

In California, the leafhoppers leave the cultivated areas during October and November, and fly to the desert foothills. At that time there is rarely any freshly sprouted annual vegetation available and the leafhoppers must exist upon perennial shrubs like desert sage until the fall rains occur. In many parts of the breeding grounds these shrubs are limited in their distribution to the bottoms of desert washes, and the leafhoppers swarm upon them in enormous numbers. Under these conditions it is feasible to spray these patches of perennials and thus reduce greatly the number of leafhoppers entering the winter. Further, owing to climatic conditions and to the conformation of the breeding grounds, the leafhoppers lay their eggs in the spring upon relatively small patches of annual range weeds on canyon slopes. It is also feasible to spray many of these patches just at the time of egg-laying and destroy the females before they lay their eggs.

The average yield of beets for the period 1932-1935 inclusive was nearly 14 tons per acre, as against 12 tons per acre for the four highest seasons preceding the spray operations.

Control of Host Plants. Considerable experimental work has been done in California, Idaho and Utah on the control of Russian thistle. The seeds do not loosen until rains have soaked the plant after it dries. Campaigns for burning the dry thistle in the fall were carried out in several places in

California in 1933 and 1934, and the results showed nearly a 50% decrease in thistle following the first year's operations, and a further reduction of around 40% following the second year's operations.

Some experimental work was done with hoeing by hand, dragging with rails, and disking, and all of these operations are feasible under certain conditions. 1937 three sugar companies contracted nearly 15,000 acres of beets in the central part of the San Joaquin Valley, close to the breeding grounds.

Direct control of Russian thistle is feasible wherever the area of thistle is comparable with that of beets being grown, and where the thistle areas are not too scattered.

In all of the breeding areas, the leafhoppers breed in the spring upon range annuals. Most of these annuals are range weeds, and their presence in large amounts is due to overgrazing.

PLANT ECOLOGY IN RELATION TO THE CURLY TOP DISEASE

R. L. Piemeisel, U. S. D. A.

The curly-top disease is carried by the beet leafhopper. The worst curly-top years are those when leafhopper populations are high. These high populations are produced on weedy areas where the insect breeds on wild mustards and Russian thistle. A grass cover or one of sagebrush and grass produces few or no leafhoppers and is a desirable cover as compared to the undesirable weedy type. Up to the 80's sagebrush and grass formed an almost unbroken cover over southern Idaho. After 1900 large areas were plowed and later some were abandoned.

Russian thistle and wild mustards were introduced and covered the abandoned lands, forming breeding areas for the leafhopper. Also the remaining sagebrush areas were used more intensively by stock; the grasses began to disappear and weeds, including a native wild mustard, appeared to form another type of breeding area. By applying the methods of plant ecology it has been found that there are changes in the weedy cover of the abandoned lands; that the changes form a series in development and that under certain conditions (proper farming and grazing of the lands) the weedy areas may change to the more desirable grass or sagebrush and grass cover.

EXPERIMENTS FOR THE CONTROL OF THE BEET LEAFHOPPER IN IDAHO, 1936-37

J. R. Douglass[1] and J. A. Gillett[2]

Idaho appropriated $50,000 in 1935 as a beet leafhopper extermination fund. On April 28, 1936 the Governor requested the University of Idaho Agri-

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[1] U. S. Bureau of Entomology and Plant Quarantine
[2] Idaho Agricultural Experiment Station

cultural Experiment Station and the U. S. Department of Agriculture to assume charge of the experimental work. The work was divided into two phases. (1) Control of the beet leafhopper and (2) the breeding of beans resistant to curly top disease.

The material used in 1936 consisted of a mixture of pyrethrum, summer spray oil and kerosene, or pyrethrum and kerosene, in ratios of oil to pyrethrum from 25 to 1 to 50 to 1 gallon. The applications were made with a Super-Spray mounted on a tractor. The infestation counts were taken with a Hills' sampling cage just before the spray was applied and again in about 24 hours.

The percentages of kill ranged from 35.25 to 97.83 with an average of 79.26. Variations in the percentage of kill are evidently caused by many factors, such as per-acre application, ratio of pyrethrum to oil, temperature, humidity, and wind velocity. Factors which were not measured may have been the cause of the fluctuation in results. They are (1) size of plants, (2) weediness of field, and (3) cultural conditions of field at time of spraying. The quantity of material applied per acre ranged from 3.71 to 8.53 gallons with an average of 6.51 gallons per acre. The leafhopper population during the season of 1936 was comparatively low. The average number of leafhoppers ranged from 41 to 435 with an average of 165 per 100 beets, or 100 feet of row. The evidence indicates that the 50 to 1 and 40 to 1 ratios of oil to pyrethrum were too large and best results were obtained at ratios of 25 to 1 and 30 to 1. In general the percentage killed increased as the pyrethrum content increased and the percentage killed increased as the per-acre application increased.

In the 1937 field experiments each plot consisted of one-half acre and was divided into 4 smaller plots. Old German type R. and G. seed was planted in the NE. and SW. plots, and U. S. No. 12 seed in the SE. and NW. plots. There was a general, gradual increase in the infestation from May 20 to June 1 when an average of 26.50 leafhoppers per 100 beets was recorded. By June 3 the average infestation had increased to 90.33 per 100 beets. From June 3 to 14, inclusive, there was a marked increase in population. The number of leafhoppers increased from an average of 501 per 100 beets on June 14 to 965.33 June 16, from 1,227.33 on June 18 to 2,556.67 on June 21, and to 2,939.17 on June 23 when the peak was reached. The material used, number of applications and date applied are presented in table 1. The applications of pyrethrum and oil and of free nicotine and oil sprays, were made with the Super-Sprayer mounted on a tractor. The applications of derris and nicotine sulphate sprays were made with a common water sprayer mounted on a trailer and attached to a tractor. Records show very little difference in beef leafhopper infestation on nonresistant (old type) and resistant (U. S. No. 12) strains of beets until June 23 when the resistant plants began to "break down" with curly top. Following the "break down" the leafhoppers began to move from the old type to the resistant beets. Of the materials tested only pyrethrum and oil gave any specific control. In the pyrethrum and oil plots the decrease in population ranged from 76.12 percent to 86.6 percent, but within a few days the infestation would again be comparatively general over the whole field by redistribution from other plots, nullifying the results. The results of the disease counts show no significant difference between the various treated plots or between the control or untreated plots.

Table 1

Number of applications made and material used in control experiments at Buhl, Idaho, 1937

Exp. No.	Plot No.	Spray material applied		Number of applications	Date of applications
	1	Control or untreated		-	-
	14			-	-
1	2	Kerosene	20 parts	2	6/4-10
2	6	Oil	10 parts	3	6/4-10-17
3	10	Free nicotine	2 percent	4	6/4-10-17-23
4	3	Derris	2 pounds	2	6/4-10
5	7	Areskot	6.4 ounces	3	6/4-10-17
6	11	Water	50 gallons	4	6/4-10-17-23
7	4	Kerosene	20 parts	2	6/4-10
8	8	Oil	10 parts	3	6/4-10-17
9	12	Pyrethrum	1 part	4	6/4-10-17-23
10	5	Nicotine sulphate	1 quart	2	6/4-10
11	9	Summer oil emulsion	1 gallon	3	6/4-10-17
12	13	Water	100 gallons	4	6/4-10-17-23

VARIETAL TESTS FOR RESISTANCE TO SUGAR BEET NEMATODES

F. V. Owen, Gerald Thorne, and C. W. McBeth -
U. S. D. A.

Several attempts have been made during the past ten years to select sugar beets resistant to the sugar beet nematode. Efforts to compare these selections with standard varieties encountered considerable difficulty because the first selections were not made from curly-top resistant varieties. Experiments in 1935 and 1936 were particularly disappointing because curly top developed in the experimental trials resulting in greatly reduced yields, and the added effect due to nematodes was difficult to measure. In 1935 selections for nematode resistance were made from U. S. #1 and U. S. 34 which are known to possess curly-top resistance. The U. S. #1 selection was evaluated in 1937 in comparison with 14 other curly-top resistant strains.

No particular nematode resistance was observed with the selection from U. S. #1 and neither did any of the other 14 varieties show any marked nematode resistance. The more vigorous varieties appeared to give relatively better results under the nematode exposure, but the statistical interactions were not found to be significant.

ALFALFA RESISTANT TO THE STEM NEMATODE

Gerald Thorne, U. S. D. A.

An unusual illustration of nematode resistance in alfalfa was found on the Utah State Agricultural College varietal test plot near Midvale, Utah, in

1936 and 1937. This plot had inadvertantly been established on an old alfalfa field which formerly was heavily infested with the alfalfa stem nematode, Ditylenchus dipsaci. Among the many varieties planted was one known as Turkestan 19304 which was found to possess almost perfect immunity to stem nematode while adjoining plots of Utah Common, Grimm, Ladak, etc. were severely damaged.

Efforts to find nematode resistant sugar beets have been unsuccessful but the fact that nematode resistance does occur in certain crop plants gives us hope that some day a nematode resistant beet may be discovered.

LIST OF GENETIC FACTORS AND CHROMOSOME MAP OF THE R CHROMOSOME IN BETA VULGARIS

F. V. Owen and F. A. Abegg, U. S. D. A.

Fourteen characters in Beta vulgaris have been found to be inherited through simple Mendelian factors. Eight of these factors are in one linkage group and hence it is assumed that these are located on one chromosome. The chromosome presumably carrying this linkage group may be designated as the R chromosome from the factor R for red pigment. Most of the factors are either color genes or mutations for abnormalities. Special interest has been centered on a factor of self fertility; one is identified with bolting, or the annual character; and another conditions the degree of curly-top resistance.

THE INHERITANCE OF CURLY-TOP RESISTANCE IN BEETS

F. A. Abegg, U.S.D.A.

Resistance of beets to the curly-top disease is conditioned by a partially dominant factor C. Groups of plants resembling the resistant and susceptible parental strains were recovered in F_2. The postulation of the C factor is strongly dependent on a linkage with the crown color factor R. Red and white F_2 classes differed significantly in both foliage symptoms and root weights. F_3 data support the existence of the R-C linkage is generally applicable to various degrees of resistant types selected from the U. S. No. 1 and U. S. No. 12 varieties.

GENETICS OF SELF-FERTILITY AND SELF-STERILITY IN SUGAR BEETS

F. V. Owen, U.S.D.A.

Sugar beets may be classified into three classes with regard to self-fertility: Highly self-fertile, intermediate, and strongly self-sterile. Environmental conditions influence the expression of these heritable tendencies. Under special conditions selfed seed can even be secured from strongly self-sterile plants, but this is not associated particularly with health and vigor.

The healthiest and most normal plants frequently show the highest degree of self-sterility. This condition is explained on the basis of chemical substances in the stylar tissue which prevents pollen tube growth. A single Mendelian factor SF will produce self-fertility and can be readily transferred from self-fertile races to self-sterile races.

THE INHERITANCE AND UTILIZATION OF MALE STERILITY IN SUGAR BEETS

F. V. Owen, U. S. D. A.

Male sterility in beets is brought about by pollen abortion. Completely male sterile plants may develop normal female flower portions although their pollen is aborted. This character is presumably inherited by complementary factors. Male steriles can be crossed with certain known complements bearing normal flowers and the result is complete male sterility in the hybrids. Therefore, one may speak of the character as being dominant and in this sense it differs from most male sterility reported in other plants.

Male sterility in corn and sorghum is recessive and perhaps of little use in a breeding program. The dominant nature of male sterility in beets makes it of considerable practical interest in connection with hybrid vigor. By using male sterile plants complete hybridization is assured with possibilities of the well known increase in growth known as hybrid vigor.

THE COMPARATIVE RATE OF BOLTING IN VARIOUS CROSSES BETWEEN ANNUAL AND BIENNIAL STRAINS OF BEETS

F. A. Abegg, U.S.D.A.

This paper presents data on the comparative rate of bolting or seedstalk development of F_1, F_2 and backcross progenies derived from crosses of Munerati's annual strain with various biennial selections. The annual parental strain has a higher average rate of seedstalk development than F_1, F_2 or backcross progenies. Backcrosses in all combinations tested were slowest in rate of bolting.

In several crosses it was evident that the F_2 rate is somewhat lower than the rate of bolting of F_1 plants. A tentative explanation for these results is based on the combined effects of the annual factor B and the probable action of several independent modifying factors.

ABSTRACTS OF RUSSIAN PAPERS

J. W. Pincus, International Consulting Agriculturist

Abstracts read by title.

WILD SPECIES OF GENUS BETA

G. H. Coons, U.S.D.A.

An arrangement of species within the genus Beta somewhat along lines originally proposed by Transchel and in part followed by E. Ulbrich (Engler and Prantl, Die Naturlichen Pflanzenfamilien, 2nd Ed., Vol. 16c "Chenopodiaceae," 1934) is now suggested as a workable system for American workers.

Section I. Vulgares Ulbrich.

Flowers in full blooming, upright spikes or panicles; free part of sepals mostly longer than the fruit, keeled in back, at the top more or less hooded, not petaloid, stigmas 3, seldom 2 or 4, pointed or blunt. Distribution coastal, Mediterranean countries, extending northward on Atlantic coast of Europe; also coastal in Asia.

1. Beta vulgaris L.

It is generally conceded that B. vulgaris L. includes a wide range of forms such as B. maritima L., B. perennis L., etc., as well as the cultivated types. Beta maritima is retained as a convenient name for the common wild beet. Various intergrades are found in B. maritima with other forms of B. vulgaris. The other species listed in this section are probably not distinct from B. vulgaris, considered in a broad sense. They are retained, however, provisionally as convenient designations in the same way that B. maritima serves.

2. Beta macrocarpa Guss. (B. bourgaei Coss.)

3. Beta patula Ait.

4. Beta atriplicifolia Rouy.

Section II. Corollinae W. Transchel.

Sepals more or less petal-like, white, yellowish or reddish; upright plants mostly with abundant-flowered paniculate stalks. Distribution chiefly Asia Minor steppes.

5. Beta trigyna Waldst. & Kit.

6. Beta lomatogona Fisch. & Mey.

7. Beta intermedia Bunge.

8. Beta macrorphiza Stev.

9. Beta nana Boiss. & Heldr.

(B. nana is placed in a separate Section "Nanae" by Ulbrich, but is considered as a subspecies of B. lomatogona by Zossimovitch).

Section III. Procumbentes Ulbrich (emend).

Flowers 1-3, clustered in axils of upper leaves; free portions of sepals short, mostly not exceeding fruit. Prostrate strand plants in western Mediterranean area, Canary, Cape Verde, and Madeira Islands.

10. Beta patellaris Moq.

11. Beta procumbens Chr. Sm.

12. Beta webbiana Moq.

The genus has received various types of handling so that the Index Kewensis lists 19 species and in the literature 50 or more names have been applied to collections, essentially represented in the above listing of 12 species.

As certain systematists have subdivided the genus into many species, other, such as Zossimovitch, have combined species into fewer group species, indicating the species as enumerated above as subspecies. Thus Zossimovitch combines B. lamatogona, B. nana, B. intermedia into one species. In the Vulgares group, there is one species, all others being considered subspecies. In all, seven species are recognized by him.

When more genetic information is at hand and with fuller information as to intercrossing and intergrades, a superior basis for classification will be supplied, but pending such study, in the writer's opinion, it is convenient to retain from the older classifications the outstanding distinctive forms as "species."

Interesting relationships doubtless will be revealed as the studies go forward. It is to be expected that intercrossing will readily be effected among the members of the Vulgares Section. Here the 2n number of chromosomes is 18; the literature already reports B. maritima crossing readily with cultivated forms of B. vulgaris. Rimpau very early gave evidence easily interpretable as indicative of a fertile hybrid being obtained between B. patula and sugar beet. Observations indicate that B. patula crosses with B. maritima. B. atriplicifolia has crossed readily with sugar beet.

B. trigyna has been hybridized by Tschermak with sugar beet, and F. Schneider has repeated this cross and studied the back-cross with sugar beet. Since B. trigyna exists as a form in which the 2n chromosome number is 36, and as a so-called variety "hexaploidea" from Crimea, in which the 2n number is 54, very interesting results may come from this study.

The chromosome number of Group III, so far as is known, is n = 9. Interspecific crosses between species of Group III and B. vulgaris have not as yet been positively obtained. Schneider has informally reported results which he interprets as a cross of B. procumbens with the sugar beet. The F_2 plants were, however, pure sugar-beet types, with no clear-cut segregations. Attempts at crossing B. patellaris with sugar beet made by Dewey Stewart were not positive, but reactions of B. patellaris fruits hand-pollinated with B. vulgaris pollen were suggestive that crossing infrequently may be obtained.

In working with the collections now available, it must be borne in mind

that the material represents only a very limited range of the biotypes of any species. Negative results from crosses, or failure to find desired characters, does not mean that the possibilities are exhausted. The evidence now at hand could be interpreted to mean that hybridizations between groups may be obtained as more extensive collections are employed.

What in the way of improvement in sugar beets may come from utilization of wild forms as a source of new genes is, of course, unpredictable. Immunity to curly top, to leaf spot, and resistance to draught and cold, and other highly desirable characters are shown by certain wild species. The utilization of these factors depends upon research which will develop methods for bringing them into the B. vulgaris complex. With other crop plants, recourse to new genes has been a fruitful technique. It is not too optimistic to believe such may be the case with the wild species of Beta.

SOME OBSERVATIONS ON WILD BEETS (BETA MARITIMA)

H. W. Dahlberg, Great Western Sugar Co.

For the purpose of discussion I shall use two main groups, as follows, to describe Beta Maritima:

1. Mediterranean
2. Atlantic (often called Beta Maritima Atlantica)
   a. North Sea Type

The Mediterranean group contains many types which are either annuals or have a great tendency to bolt the first year. The plants are small, lower in sugar than the Atlantic type, very much sprangled as to root shape, and have a very high percentage of deep red or pink hypocotyls. A great many of them have multiple crowns. Some have a considerable redness factor in the seed balls before they mature.

Munerati, in Italy, has probably made a more thorough study of the Mediterranean types than any other plant breeder. I therefore think it would be well to include in this paper the following conclusions which he has made:

"THE CROSSING OF CULTIVATED BEETS WITH THE TYPE GROWING WILD ALONG THE COAST OF THE ADRIATIC"

"Observations for 20 years at the R. Experiment Station at Rovigo have permitted some conclusions which are judged to be definite.

1. It must be noted at first that the beets growing spontaneously along the coast of the Adriatic (around the mouth of the Po) comprise a population from which there have readily been separated several tens of bio-types having external characteristics, fixed and transmissible. (Some of these bio-types differ greatly from those which are separable among the cultivated varieties.)

2. Direct examination of the said wild forms has permitted the verification of the fact that a certain number of individuals, more or less noticeable depending on the year, are biennials (either actually, or due to a

tardy germination of the seed). This fact repeats itself with absolute parallelism when the wild type is placed under controlled cultivation. It is this subject of biennial equilibrium which we have set apart for our work.

3. In the first attempts at crossing with cultivated beets we have purposely chosen, among the wild types, the individuals of hereditary characteristics well fixed by selection, and the results have appeared directly so encouraging that we were induced to resolutely repeat the work with the aid of the most abundant material possible.

4. Among the many singular results immediately brought about by the crossing must be noted the great expansion and vigor of the aerial parts (demonstrated by us and also by Mm. Saillard and Villmorin). At the same time the leaves of the greater number of strains possessed a distinct resistance to drought and to two diseases (disease of the heart and Cercospora (leaf spot) which, in that region, very often attack beets during the autumn. In certain years of heavy attack by Cercospora, there has been recorded 4-5% more sugar in the crossed lines than in the ordinary beets cultivated under the same conditions.

5. In opposition to this important fact of heterosis must nevertheless be noted the characteristics of an absolutely undesirable top root, causing a tendency to the rooty type and to other characteristics peculiar to the wild beet.

6. The succeeding work of selection in the attempt to eliminate as far as possible the individuals having the characteristics of the wild type, showed that when the form of the root was improved there was a simultaneous decrease in the vigor and growth of the leaves, as if there existed a repulsion of antagonism between these two characters.

7. Among the large number (several thousands) of strains studied during 12 years, we have succeeded in separating and establishing lines which show a satisfactory growth of aerial parts, a great resistance to drought and disease, as well as a perfect root form.

8. The aforesaid lines were obtained in commercial quantities and in 1923 were planted on a large scale (several hundreds of hectares) in several Italian beet districts with results which encouraged continuation, because the crossed types, maturing late and having a great resistance to Cercospora, could be profitably harvested during the latter part of the campaign."

The wild beet is very fond of a moist, salty atmosphere and the name Beta maritima was well chosen. In a number of places I found beet plants about two months old and not in the seed stage, which were actually washed by salt water at high tide. One is impressed with the hardiness of the plant when one sees under what adverse conditions it will grow. At Cancale, France, I found a plant growing in a tiny crack in the vertical sea-wall where it had found a little soil. Near Weymouth, England, many plants were growing in gravel consisting largely of round rocks three inches in diameter, deep enough so the roots must have gone down three feet or more.

It was interesting to see Italian and North Sea types growing side by side in Dr. Tjebbes garden in Sweden, the same as we had them at Longmont in 1934. In both cases, with the great difference in climate between Colorado and

Swedon, the Italian type was an annual, producing seed, and the North Sea type was a biennial. The Swedish climate is very favorable to bolting, while ours is unfavorable, so this emphasizes the hereditary character of bolting.

Dr. Tjebbes has the following to say of the North Sea type of Beta maritima in a bulletin he published on the subject:

"ADAPTATIONS"

"The North Sea type of B. Maritima must be looked upon as an eco-type (Turresson 1922 a. 1925). Besides being morphologically well characterized it presents several physiological and anatomical traits that make it specially adapted to its surroundings. It is perfectly hardy (in many cases winter-green), and endures at least 18 centigrades of frost, thus being able to stand our winters, while all southern forms of beets are killed at about -5°. The very long, branched roots enable it to anchor and to establish itself on pebble- and sand-beaches and on rocky slopes. The prostrate stems, from which new secondary stems frequently arise, give the plant a most ideal shape to stand against pressure of air and water. If any part of the plant is covered by sand or sea weeds, some other part may be still free to take over its functions, some secondary rosette becoming a new centre of vegetation. The fleshy leaves are a typical halophyte-character. The root has a remarkably high sugar content, much higher than that of the south-European wild beets. This of course makes it more frost-hardy. The number of vascular cylinders is very high, which secures tough roots and is probably a condition for sugar content. The comparatively low ash-content of the root saps must be interpreted as a consequence of a special capacity of living in a soil that is very rich in salts. I have found the same capacity in certain races of sugar beet, that, remarkably enough, happen to have many morphological characters in common with the North-Sea wild beet."

PART 2

In our search for genes and for certain desirable gene combinations which may not be present in our cultivated sugar beet, we have for the last few years somewhat concentrated on the North Sea type, as this type looked more promising than any of the others. The wild beets grown at Longmont test about 10% to 14% sugar and 76 to 82 purity.

ANALYSIS OF PARENT HYBRID AND DAUGHTERS

Family	Dahlberg 4	544	546
Description	Dahlberg 4 Original	D_4 grouped with D_3 and 12028	D_4 grouped with D_3 and 12028
Weight per beet, ounces	23.0	-	32.2
Sugar, %	12.70	14.50	12.65
Brix Press Juice	15.0	17.5	15.0
Purity	89.1	90.2	88.7
Nitrate Nitrogen, %	0.0042	0.0022	0.0063
Total Nitrogen	0.0886	0.1019	0.1110

The next series of pictures and analyses show that while there is plenty of segregation for size and shape of roots, the analyses of the beets

show a much more satisfactory composition than would be indicated from the appearance of the roots.

RESULT OF BACK CROSS (NORTH SEA HYBRID x DOMESTIC BEET 12028)

	Family #550 (from 12028)	Family #546 (from Dahlberg 4)	Family #521 (from Dahlberg 3)	
Number of Beets	20	18	37	
Avg. Weight in ounces	12.1	13.4	7.8	
% Sugar	16.4	16.5	15.2	
Apparent Purity (Brix)	89.3	90.4	89.9	
Leaf Spot Reading Sept. 17	4.0	2.0	3.0	
" " " for U.S.#217				3.1

WILD BEETS IN CALIFORNIA

Eubanks Carsner, U. S. D. A.

Annuals of the genus Beta occur in several coastal counties of southern California and also in the central part of the state near San Jose. These plants appear to be hybrids between cultivated sugar beets and wild forms of foreign origin. They persist without cultivation. They are subject to the same diseases as the sugar beet and may have some economic interest on this account.

A distinctly wild type of beet occurs in several scattered places in the Imperial Valley. It is dependent on irrigation water for survival. Presumably it was introduced with seed from Europe. At present it does not appear to be of economic importance.

GREENHOUSE OBSERVATIONS OF WILD BEET SPECIES

F. A. Abegg, U.S.D.A.

A demonstration of wild beet species.

POSSIBILITIES OF IMPROVING CULTIVATED VARIETIES OF BEETS OF SUGAR BEETS BY HYBRIDIZATION WITH WILD TYPES

C. W. Doxtator, American Beet Seed Company

Intergeneric and Interspecific crosses in crops are, in general extremely difficult to make, and if successful the progeny is likely to show a high degree of sterility. The plant breeder, therefore, has been limited to a great extent in attempts to produce more suitable cultivated types, to hybridization

and selection within a species. In many cases however, species crosses have real economic possibilities and for this reason workers in the field of plant improvement in recent years have given a good deal of attention to this problem.

In the Genus Beta, the so-called wild species do offer some promise in the breeding program. Resistance to Cerospora leaf spot has been observed in B. maritima. There is also the possibility of obtaining more resistance to the Curly Top disease and resistance to Downy mildew from wild types. Some species show marked resistance to drought conditions, as well as adaptation to saline soils. Wild types also show adaptation to different altitudes and to different temperature conditions. The characteristic of the single germ seed ball is a also an important property and may be of value in beet improvement work. Other desirable characteristics are likely to be observed when more varieties of wild types are collected and their progenies critically studied.

The possibility of success in the transfer of desirable wild beet characteristics to the sugar beet depends on many factors. The difficulties of making the cross, and the sterility of the hybrid are the first difficulties to be encountered. Backcrossing the hybrid to the sugar beet parent appears to be the most promising breeding method for rapid progress. Characters simply inherited may be reasonably easy to transfer but with quantitative characters it is likely that only partial success will be obtained with each cross attempted.

Despite the difficulties to be encountered in wide crosses, failure to achieve the objective is by no means indicated. Interspecific hybrids have probably been studied more extensively in Triticum than in any other farm crop. As an indication of the possibilities of this type of crossing it must be stated that the variety of common wheat named Thatcher is the result of a species cross (Triticum durum X Triticum vulgare) and combines to a very high degree the black stem rust resistance found in durum wheats with some rust resistance and the very high milling quality of the common bread wheat type. Originating at the Minnesota Experiment Station this variety promises to supplant to a very great extent the usual varieties grown in the hard red spring wheat of North America.

In the Genus Beta several species crosses have been reported as successful. Cytological studies made on some of the hybrids have given some information in regard to chromosome relationships. There is great need however for continued cytological investigation of species hybrids in order that more information be made available on the basic causes of their sterility.

Recently the discovery of the effects of Colchicine on plant growths has enlarged the field for the synthesizing of artificial species. Species crosses commonly found sterile can now be more easily made fertile true breeding species by treating withcolchicine to double the chromosome number. The economic value of the tetraploid and other polyploid Beta types which can be artificially synthesized by this method is unknown.

Investigations into species crosses in Beta and into the production and study of artificially synthesized species is a field of research which should be fruitful not only in studies of inheritance but also in the production of varieties of sugar beets more suitable to our needs.

SOME OBSERVATIONS ON VARIETY TRIALS CONDUCTED IN CERTAIN HUMID AND IRRIGATED AREAS IN 1937

A. W. Skuderna and C. W. Doxtator
American Beet Seed Co.

Variety tests conducted in 1937 in 17 different localities in the 7 states in which the American Crystal Sugar Company operates, revealed some interesting relationships. Results of tests in the humid areas, namely in North Dakota and Minnesota indicate that varieties intermediate in tonnage yield are productive of greater sugar per acre yields than either the strictly tonnage or sugar varieties. In Iowa, Eastern Nebraska, and in Southeastern Colorado the sugar varieties and especially those resistant to leafspot (Cercospora beticola S) were the better performers. In California the tonnage varieties (especially those resistant to the curly top disease) and in Montana some of the intermediate types produced the highest sugar per acre yields.

From the results of this large number of tests (which are a part of a variety testing program extending over a period of years) it becomes apparent that no single variety of sugar beets can be recommended as the best one to use over a wide geographic area. It is further apparent, that breeding for adaptation of a variety or varieties for certain regions or even sub-regions is imperative from standpoint of maximum sugar per acre yields. To paraphrase F. D. Richey, Chief of the Bureau of Plant Industry "It seems clear that green pastures for the breeders of sugar beets will continue and must be pastured for some time to come."

BEET VARIETY TRIALS IN ONTARIO

H. D. Brown, Canada and Dominion Sugar Company

The Ontario commercial crop of sugar beets has been grown, chiefly from European beet seed, with a small but increasing amount of locally produced seed during the past several years. The European seed has been mostly of the "Normal" or "Intermediate" type, and in Ontario has averaged 9.2 tons per acre with 15.3% sugar, over a 35 year period. The past five years has been a little above the long time average with 10.0 tons per acre and 15.6% sugar in the beets.

Each year variety tests have been conducted on the commercial strains—

(a) to see that all come up to a general average standard.
(b) to locate the superior type of seed or firm supplying a better adapted strain.
(c) to compare Home Grown varieties and selections with the European strains.

The following table is the result of the 1937 tests. The 20 seed types were sown in 3 row blocks, 50 feet long, and repeated 5 times in randomized order. Seeding was done May 14th, and harvesting, block by block, on October 31st—November 2nd.

Commercial strains are listed only as to the country of origin, while

selected strains are designated by their source. Recoverable sugar per acre is the product of tonnage by sugar and purity.

Grading	Seed Strain	Stand	Tonnage	Sugar	Purity	Sug. per Acre
1	Ont. Sel. Gt. West.	86.6	x 11.13	x 15.22	88.0	2981
2	Holly- Gt. West.	88.4	x 11.92	14.26	87.1	2961
3	Russian - N type	87.2	x 12.10	13.90	84.6	2846
4	Russian - Z type	85.2	10.99	14.84	86.0	2805
5	Polish - Leaf Spot	84.0	o 9.91	x 16.26	87.0	2804
6	U. S. 217	88.2	x 11.38	14.04	87.1	2783
7	German - Leaf Spot	86.4	10.26	x 15.48	86.6	2751
8	Russian - E type	89.4	x 11.43	13.98	85.5	2732
9	Stokes Cross -zz type	84.2	10.53	14.84	84.7	2678
10	English Commercial	89.6	x 11.08	14.02	86.2	2678
11	German - Normal type	87.8	10.38	14.86	86.2	2659
12	German-Sugar type	85.2	10.63	14.50	86.2	2657
13	U. S. 34	87.4	10.87	13.86	86.2	2597
14	Ont. Home Grown	83.2	o 9.97	14.84	86.9	2571
15	Polish Tonnage type	85.8	10.34	14.08	86.7	2507
16	Polish Sugar type	89.6	o 8.95	x 16.00	86.9	2489
17	U.S. 1	87.6	10.24	13.96	85.7	2450
18	Dutch Commercial	84.8	10.28	o 13.58	85.6	2390
19	U. S. 14	85.2	11.05	o 12.46	83.2	2291
20	German Commercial	87.8	10.00	o 13.08	84.4	2208
Average		86.7	10.67	14.40	86.1	2642
Diff. for Significance		5.0%	.496	.66	1.6%	

x types significantly above average for sugar or tonnage
o types significantly below average for sugar or tonnage

BEET VARIETAL TRIALS IN MICHIGAN, OHIO, INDIANA AREA

M. J. Buschlen, Farmers and Manufacturers Association

The variety testing work of the Farmers and Manufacturers Beet Sugar Association was carried on this past season in two locations, --one at Fairgrove, Michigan and the other at Holgate, Ohio. It may be said that this year was very discouraging from an experimental standpoint because of the severe wet weather and the terrible epidemic of blight which struck shortly after the first of August and continued until the harvest season.

On these plots there were a total of 32 varieties tested, but I shall report on only 14 varieties, 13 of which are of domestic origin and one commercial, which was used as a check.

These varieties were tested in plots 100 feet long, eight rows wide, and were replicated six times. The beets from the center four rows were counted, tared and weighed for yield. Twenty beets were selected at random for a

sugar sample. A sugar and purity analysis was made in cooperation with Mr. J. G. Lill in the U. S. Department of Agriculture Testing Laboratory at East Lansing, Michigan.

Rank	Variety	Tons Per Acre	Percent Sucrose	Percent Purity	Recoverable Sugar
1	U.S.D.A. #217	14.43	17.61	85.88	4,276.1
2	Am. Crystal #4	14.06	16.85	85.21	4,018.8
3	Great Western	13.39	17.22	87.12	3,878.6
4	U.S.D.A. #34	13.01	17.13	86.61	3,860.0
5	Am. Crystal #3	12.78	16.63	85.23	3,670.0
6	U.S.D.A. #33	13.11	16.44	84.84	3,646.5
7	Stokes Home Grown	11.66	18.18	85.83	3,631.6
8	M.S.C. Check	12.30	16.83	85.17	3,550.3
9	Am. Crystal #1	11.98	17.09	85.54	3,508.0
10	Commercial Check	12.73	15.87	84.53	3,404.6
11	Am. Crystal #5	10.89	18.10	86.19	3,399.0
12	Holly Special	11.18	16.62	85.32	3,187.8
13	Kohls Elite	10.37	17.13	84.93	3,026.1
14	Amalgamated #600	11.71	15.68	82.55	3,017.0
Statistical Dependability		over 99%	over 99%	over 19%	over 99%
When values differ more than		1.95	1.1%	2.11%	640#

Ranked according to Recoverable Sugar

According to the statistical analysis (Fisher's method) of our data from the Fairgrove test, we find it requires a difference of 1.95 tons and a difference of 1.1% Sucrose, and a difference of 640 lbs. of sugar per acre for 1% significance, or odds of 99 to 1. The purity figures are only significant to 5%, or odds of 19 to 1.

A careful study reveals that U.S.D.A. #217 heads the list, probably because it carries considerable resistance to blight. It is significantly better in tonnage than seven of the other varieties included in the test. American Crystal #4, which was the next best, is significantly better in tonnage than six of the other varieties. These two were also outstanding in the test last season, however, none of the varieties are significantly better in tonnage than the Commercial Check.

Seven varieties appear to be significantly better in Sucrose content than the Commercial Check. U. S. #217 appears to be significantly better in the amount of recoverably sugar produced than the Commercial Check, as well as being significantly better than seven other varieties included in the test.

Variety	Fairgrove, Michigan Av. Size of beet Pounds	% Stand	Holgate, Ohio Av. Size of beet Pounds	% Stand
U.S.D.A. #217	1.39	87	.56	65
American Crystal #4	1.18	100	.54	68
Great Western	1.13	100	.49	70
U.S.D.A. #34	1.23	89	.49	65
American Crystal #3	1.24	87	.50	71
U.S.D.A. #33	1.16	95	.45	67
Stokes Home Grown	1.23	80	.51	71
M.S.C. Check	1.36	76	.57	65
American Crystal #1	1.14	72	.46	63
Commercial Check	1.23	87	.52	75
American Crystal #5	1.15	80	.46	62
Holly Special	1.21	78	.52	74
Kohls Elite	1.02	86	.41	74
Amalgamated #600	1.12	88	.50	61
Average	1.2	86	.5	68

The results of two years trials are shown in the following table:

VARIETY SERIES - Fairgrove, Michigan
Average for 1936 and 1937

Rank	Variety	Tons per Acre	Percent Sucrose	Percent Purity	Recoverable Sugar
1	Am. Crystal #4	12.71	17.37	86.61	3,802.8
2	Am. Crystal #3*	12.78	16.63	85.23	3,670.0
3	U.S.D.A. #34	12.16	17.26	87.11	3,653.4
4	U.S.D.A. #217	11.99	17.25	88.44	3,542.6
5	Great Western	11.83	17.31	87.28	3,502.6
6	Am. Crystal #1	11.36	17.39	85.59	3,433.5
7	Am. Crystal #5*	10.89	18.10	86.19	3,399.0
8	Commercial Check	11.83	16.68	86.03	3,376.8
9	U.S.D.A. #33	11.43	17.22	84.03	3,283.6
10	M.S.C. Check	11.07	17.06	84.89	3,264.1
11	Holly Special*	11.17	16.62	85.32	3,187.8
12	Stokes Home Grown	9.78	17.99	87.90	3,081.2
13	Amalgamated #600	10.42	16.24	84.83	2,845.6
14	Kohls Elite	9.23	17.36	85.92	2,749.4

* - 1937 only

It is interesting to note that when the results of the two years - 1936 and 1937 are combined U. S. #217 is not on top but holds up very well. In 1936 very little blight occurred, while in 1937 a severe epidemic of blight was encountered, indicating we will probably not be penalizing ourselves greatly in not blight years by using blight resistant seed to protect us in years when blight might occur.

The following table shows the results of the trial at Holgate, Ohio:

Rank	Variety	Tons per Acre	Percent Sucrose	Percent Purity	Recoverable Sugar
1	Commercial Check	4.60	16.83	85.18	1,321.3
2	U.S.D.A. #217	4.35	17.12	86.72	1,311.1
3	Holly Special	4.58	16.72	85.48	1,309.3
4	M.S.C. Check	4.36	17.04	85.67	1,275.5
5	Stokes Home Grown	4.32	17.66	85.63	1,250.0
6	Am. Crystal #3	4.21	16.73	85.54	1,212.5
7	Am. Crystal #4	4.36	16.32	83.71	1,190.0
8	Great Western	4.10	16.60	85.89	1,160.8
9	U.S.D.A. #33	3.54	17.16	86.85	1,058.6
10	Kohls Elite	3.60	17.16	85.71	1,058.0
11	U.S.D.A. #34	3.74	16.53	85.26	1,048.8
12	Am. Crystal #1	3.43	16.78	85.42	1,026.0
13	Am. Crystal #5	3.42	17.15	86.85	998.8
14	Amalgamated #600	3.61	15.77	84.31	987.0
Statistical Dependability		over 99%	over 99%	over 19%	over 19%
When values differ by more than		2.44	.96	1.62	225.7

Ranked according to recoverable sugar

Due to the very extreme wet weather the results are very disappointing. A careful study reveals that very little significance occurs in this data. I am inserting it only as a matter of record. It has very little value from an experimental standpoint in determining the worth of the various varieties.

OTHER STATE TESTS WITH U. S. #217

In 1937 we harvested 53 plots of blight resistant seed in direct comparison to the ordinary commercial seed which was being used in the various territories. Due to limited time and space I shall not insert the data here but suffice to say that in the majority of cases U.S. #217 showed up better than the ordinary commercial, in some instances as much as 15% increase was noted in favor of U.S. #217 over the ordinary Commercial variety.

TESTS OF U. S. 217 IN 1937

G. H. Coons, Dewey Stewart, J. O. Gaskill, G. W. Deming, H. W. Bockstahler, J. O. Culbertson, and S. B. Nuckols, U.S.D.A.

Following is a report on agronomic tests conducted with U. S. 217 in 1937. This variety, formerly called Acc. 217 or Acc. 220, is composed of 5 leaf-spot-resistant inbreds allowed to intercross. Details of the make up of this variety have been given in the first report made last year and in the 1936 U. S. Department of Agriculture Yearbook, page 641.

A summary of 11 intensive tests of U. S. 217 in comparison with a

SUMMARY OF 1937 TESTS OF U. S. 217

Conducted by the Division of Sugar Plant Investigations

Test No.	Location of Test	Acre-yield of roots[1]		Sucrose		Apparent Purity Coefficient		Calculated Acre-Yield of Sugar			
								Gross		Indicated available	
		U.S.217	Check[2]	U.S.217	Check	U.S.217	Check	U.S.217	Check	U.S.217	Check
		(tons)	(tons)	(%)	(%)			(lbs.)	(Lbs.)	(Lbs.)	(Lbs.)
1	Ft. Collins, Colo. Field Station(Sprinkler)	14.48	13.73	13.88	11.45	92.00	90.17	4,033	3,156	3,714	2,850
2	do	17.10	15.89	15.00	13.59	91.39	90.36	5,127	4,311	4,685	3,899
3	Ft. Morgan, Colo. Farmer's field	19.58	21.01	13.26	11.90	91.55	89.64	5,197	4,990	4,760	4,472
4	Ft. Collins, Colo. College Farm	18.02	16.86	15.46	14.08	95.13	94.59	5,567	4,743	5,292	4,489
5	Ft. Collins, Colo. Agronomic test	17.00	17.66	15.06	13.52	93.78	92.90	5,134	4,762	4,814	4,423
6	Rocky Ford, Colo. Exp. 1, Sprinkler	18.04	21.52	12.48	10.77	91.28	89.43	4,490	4,634	4,099	4,144
7	" Exp. 2,	19.20	18.65	11.92	10.56	89.08	89.60	4,540	3,928	4,035	3,511
8	Rocky Ford, Colo. West Ranch	17.59	19.12	15.51	14.48	96.18	96.16	5,458	5,544	5,248	5,329
9	Crookston, Minn.	6.32	8.00	16.80	16.62			2,130	2,661		
10	Waseca, Minn.	12.60	13.04	16.19	16.22	83.50	83.80	4,080	4,234	3,367	3,555
11	Scottsbluff, Nebr.	17.32	18.16	15.34	15.01	85.90	84.40	5,346	5,480	4,606	4,630
Average of 1937 tests		16.11 ±.58	16.69	14.63 ±1.16	13.47	90.98 ±.88	90.10	4,646 ±242	4,404	4,462 ±332	4,130
Average of 16 tests in 1936		14.09 ±.20	14.29	14.89 ±.79	14.10	86.24 ±.59	85.65	4,157 ±175	3,982	3,589 ±168	3,421

1/ Tests 1 to 8, inclusive, are based on normally-competitive beets; tests 9, 10, and 11 are based on actual yields.

2/ In tests 1 and 6, Old Type was used; in others, Synthetic Check.

check, as conducted in 1937 by members of the Division of Sugar Plant Investigations is presented. On the basis of the 1937 test, the guarded conclusion is drawn that the variety performed satisfactorily where tried, except in Minnesota where, because of low acre-yield of roots and sucrose percentage about equal to the check, the calculated acre-yields of sugar were significantly below the yield of the check. The leaf-spot resistance of the variety was conclusively shown; strongest superiority of the variety over check was manifested in those cases in which leaf spot was a serious factor.

VARIETY TESTS BY THE HOLLY SUGAR CORPORATION

C. E. Cormany, Chief Agronomist

Three brief summary charts are shown covering results of the variety tests in (a) Montana and Wyoming, (b) Western Slope of Colorado and (c) The Hamilton City, California, area.

American varieties are compared to a standard commercial check of the intermediate type in the California and Montana-Wyoming tests, U. S. 34 being used for check in the Delta test.

From the data presented in these tables, the American varieties compare favorably with, or exceed the yields of the check and are not significantly different from the check in the California and Montana-Wyoming areas.

In the curly-top area near Delta, Colorado, curly-top resistant strain, U. S. #12, was better than U. S. #34 and #600 but not significantly so.

The non-curly-top resistant varieties were inferior to the curly-top resistant varieties in the Delta tests, as was to be expected.

Variety Summary--Hamilton City, California--Total Plant Yield

Variety	% Sucrose	Tons per Acre	Sugar Per Acre
U.S. 33	17.63	13.588	4808
U.S. 34	17.33	14.815	5160
U.S. 36	18.23	13.896	5059
HGW 36	17.90	15.535	5559
Check	17.40	14.638	5102
Z Value	.5295	.7634	.5702
5% Point	.4090	.4090	.4090
Diff. Req. for Sig.	.8636	1.7332	.647
SEm in % Gen. M.	1.74%	4.32%	4.59%

According to these analyses no variety differs significantly from the commercial check.

Variety Summary---Montana & Wyoming---Comp. beet Basis

	Loc.	US 34	US 217	HS 36	HGW 36	Check	SEm	Dif Req For sig	SEm in % GenM
	Torr.	15.4	15.4	16.1	15.9	15.1	.3201	.0954	2.05
%	Wor.	16.9	16.8	16.8	16.8	17.4	.4717	1.3342	2.77
Suc.	Sher.	16.0	15.8	15.6	15.6	15.9	.2250	.6364	1.43
	Sid.	15.0	14.8	15.4	14.8	15.4	.2494	.7054	1.62
	Ave.	15.8	15.7	16.0	15.8	16.0			

SE of a General Mean - .1654

Diff. req. for significance - .1654 x $2\sqrt{2}$ = .4678

	Torr.	21.894	19.727	22.436	22.515	23.347	.8719	2.4661	3.94
Tons	Wor.	21.704	21.434	18.480	22.789	20.571	.7479	2.1204	3.53
Per	Sher.	17.509	16.934	17.850	18.742	16.052	.7558	2.1378	4.47
Acre	Sid.	17.560	16.877	18.452	19.766	19.478	1.0006	2.8301	5.55
	Ave.	19.667	18.743	19.304	20.953	19.862			

SE of a General Mean = .4251

Diff. req. for significance = .4251 x $2\sqrt{2}$ = 1.2024

	Torr.	6729	6080	7199	7163	7064	315.50	892	4.56
Sug.	Wor.	7338	7194	6226	7692	7181	453.59	1283	6.27
per	Sher.	5578	5351	5544	5838	5101	250.66	709	4.62
Acre	Sid.	5261	4992	5682	5842	5991	283.98	803	5.12
	Ave.	6226	5904	6163	6634	6334			

SE of a General Mean = 167.47

Diff. req. for significance = 167.47 x $2\sqrt{2}$ = 473.67

According to these analyses no variety differs significantly from the commercial check.

Variety Summary---Delta Colorado---Comp. beet basis

Variety	% Sucrose	Tons per Acre	Sugar Per Acre
U.S. 12	18.19	17.80	6461
U.S. 34	17.86	17.03	6068
600	17.38	17.20	5977
U.S. 217	18.09	13.46	4870
H.S. 36	18.60	15.18	5648
HGW 36	18.08	13.37	4828
Z Value	.9607	.9647	.9715
5% Point	.4783	.4783	.4783
Diff. req. for Sig.	.4372	2.108	714
Sem in % Gen. M.	0.86%	4.75%	4.47%

According to these analyses no variety is significantly superior to U. S. 34 in yield per acre in tons or sugar per acre but U.S. 217 and H.G.W. 36 are significantly below U.S. 34. In % sucrose H.S. 36 is significantly superior to U.S. 34 and 600 is significantly inferior to U.S. 34.

COMMERCIAL VARIETY TRIALS, 1937, BRUSH, COLORADO

H. L. Bush, National Seed Company, Inc.

This complete test included all of the important European varieties as well as the American productions. For the purpose of this report the results of the various European varieties are not included since the committee in charge of the program has decided not to have them reported.

It may be stated that R & G "Normal" which was used as a check in this test was purchased from the Sugar Company out of their regular commercial stock so that a true picture of the varietal performances could be obtained.

The results which are presented were taken from a field which had been artificially infected for leaf spot so that a very severe infection resulted.

Results are as follows:

	Actual Yields			Compared to check 100%			
Variety	Beets Tons per Acre	Sucrose in percent	Sugar Lbs. Per Acre	Beets Tons Per Acre	Sucrose in Percent	Sugar Lbs. per Acre	Leaf spot Reading
R&G"N"check	16.56	13.94	4617	100.0	100.0	100.0	4
R&G"C"2152	15.75	15.31	4823	95.1	109.8	104.5	2-1
R&G"C"2153	13.95	16.07	4484	84.2	115.3	97.1	1-2
U. S. #217	15.80	15.06	4759	95.4	108.0	103.1	2-1
Great Western	17.87	14.33	5122	107.9	102.8	110.9	3-4
U. S. #33	15.44	13.59	4197	93.2	97.5	90.8	4
U. S. #34	14.90	13.27	3954	90.0	95.2	85.5	4
Amalgamated 600	15.26	13.69	4178	92.1	98.2	90.4	4
Diff for Sig	1.31	.11	578				

These results show that Great Western yields good in sugar per acre under these conditions of severe leaf spot infection, while not exhibiting much apparent resistance, but since this sugar yield comes from a comparatively high tonnage; whereas, the good yields of U.S. 217 and R & G 2152 are made up from a lower tonnage and high sucrose content. The problem of handling the beets economically might be a deciding factor to determine the more desirable variety.

R & "C" 2152 and 2153 are varieties developed as a result of our trial field in Spain.

Tests of the Curly Top Resistant varieties were also conducted at Delta, Colorado, under quite severe curly top infected conditions.

The results of these tests follow:

Variety	Actual Yields: Beets Tons per Acre	Sucrose in Percent	Sugar Lbs. per Acre	Compared to Check 100%: Beets Tons per Acre	Sucrose in Percent	Sugar Lbs. per Acre	Curly Top Reading
R&G "N" Check	9.05	17.27	3126	100.0	100.0	100.0	4
R&G Old Type	9.86	17.12	3376	109.0	99.1	108.1	4
Amalgamated "600"	14.49	16.38	4747	160.2	94.8	151.9	2-1
U.S. #33	13.77	17.07	4701	152.2	98.8	150.4	2-1
U.S. #34	15.30	16.73	5119	169.2	96.9	164.0	2-1
Resistant Mix	14.13	16.95	4790	156.2	98.1	153.3	2-1
Diff. for Sig.	1.28	.37	420				

It may be seen from the foregoing results that the Curly Top Resistant Varieties are only adaptable to the growing conditions for which they are bred.

Apparently a universal beet will be hard to obtain.

REPEATED TESTS OF BREEDING STRAINS, BRUSH, COLORADO

In the fall of 1934 we made individual mother beet selections on the basis of leaf spot resistance from the various strains grown in our trial field that year. Seed was produced by means of space isolation from these mothers in 1935 and this seed given a preliminary test in 1936. The good performers in 1936 were retested in 1937. Results for both years being obtained under artificially infected leaf spot conditions.

A large part of this material was taken from families developed by our company for resistance to leaf spot in Spain so we are assured that there must be a reasonable amount of purity for the resistant character in these particular selections. Accordingly the more desirable strains will be increased.

The results of this test follow:

Variety	Actual Yield: Beets Tons per Acre	Sucrose in percent	Sugar Lbs. per Acre	Compared to Check 100%: Beets Tons per Acre	Sucrose in Percent	Sugar Lbs. per acre	Leaf Spot Reading
R&G"N" check	15.39	13.27	4085	100.0	100.0	100.0	4
5063	14.27	15.71	4484	92.7	118.4	109.8	1
5067	13.91	16.01	4454	90.4	120.6	109.0	1
5079	13.37	15.57	4163	86.8	117.3	101.9	2-1
5081	14.94	15.45	4616	97.1	116.4	113.0	1-2
5082	15.71	15.13	4754	102.0	114.0	116.4	1-2
5083	13.86	15.40	4269	90.1	116.1	104.5	2-1
5086	13.59	16.16	4392	88.3	121.8	107.5	1-2
50594	13.23	16.61	4395	86.0	125.2	107.6	1
50595	14.99	16.48	4941	97.4	124.2	121.0	1-2
50596	16.20	15.48	5016	105.3	116.7	122.8	2-1
50598	15.84	13.61	4312	102.9	102.6	105.6	1-2
50601	14.54	15.67	4557	94.4	118.1	111.6	1-2
50603	14.00	15.41	4315	90.9	116.1	105.6	2-1

(continued next page)

50605	15.26	15.64	4763	99.1	117.9	116.6	1
50606	14.58	15.27	4453	94.7	115.1	109.0	1-2
50607	12.51	15.87	3971	81.3	119.6	97.2	1-2
50608	13.73	15.32	4207	89.2	115.4	103.0	2-1
50609	14.40	14.92	4297	93.6	112.4	105.2	1-2
50610	17.78	16.94	6024	115.4	127.7	147.5	1
50611	16.79	18.24	6125	109.1	137.5	149.9	2-1
50612	18.86	17.14	6465	122.5	129.2	158.3	2-1
50616	16.52	14.37	4748	107.3	108.3	116.2	2-1
50644	15.03	16.81	5053	97.7	126.7	123.7	2-1
50681	15.12	16.68	5044	98.2	125.7	123.5	1-2
Diff. for Sig.	1.34	.32	433				

It will be noticed that nearly all of these strains have a high sugar content with relation to the yield. This is because of selections being made from our Spanish material as the type of beet grown in Spain is the extreme sugar type.

The sugar yield is, in some cases, very satisfactory even with the rather low yield in tonnage. However, it may be stated that the tonnage for most of these strains is considerably better than that of the material from which the selections were made showing that adaptability to this country is already asserting itself in tonnage without lowering the sugar content after one year of inbreeding in this country.

We are of the opinion that this work is valuable because it can be compared with work of a similar nature in European countries where leaf spot is prevalent.

CURLY TOP RESISTANT VARIETIES

F. V. Owen, Bion Tolman, Charles Price, Albert Murphy, F. L. Larmon, Eubanks Carsner, U.S.D.A.

Curly-top areas will probably depend upon sugar beet seed from U.S.33 and U.S. 12 for a considerable portion of acreage for the next two or more years. U.S. 33 is higher in sugar and is probably acknowledged as the better variety where curly top is not a serious factor. U.S. 12 is more resistant to curly top, however, and usually gives a reasonably good performance in yield of sugar per acre. Five new strains are now to be considered as competitors with U.S. 33 and U.S. 12. These strains are known at present only by temporary numbers assigned by the Division of Sugar Plant Investigation at Salt Lake City. If any number is decided upon for commercial distribution a U. S. number will be assigned later.

The tables give comparisons of U. S. 33 and U. S. 12 and numbers 610, 611, 612, 622, and 623. At Buhl, Idaho, all of the new numbers were highly resistant to curly top, and in this respect roughly comparable with U. S. 12. Number 610 is more of a sugar type, while 622 and 623 are more on the order of yield types, and 611 and 612 are probably intermediate.

With regard to bolting tendency, number 610 and 612 may bolt nearly as

much as U.S. 33, but 611, 622 and 623 have been remarkably free from bolting in Idaho and northern Utah and may be ranked roughly with U. S. 14 under California conditions. Number 623 is of some special interest in California due to a considerable amount of mildew resistance which it seems to possess.

Before decisions are made regarding the release and distribution of the five new varieties, 610, 611, 612, 622, and 623, they will all be tested another year by the respective sugar companies who are interested as well as by government workers. This policy will insure against the hazard of hasty decisions. After another year's work it is expected that the best varieties for the respective curly-top areas can be chosen. A constructive effort to reduce the confusion caused by a large number of varieties will be possible by this policy. In the past it has been necessary to release curly-top resistant varieties rather rapidly to meet an emergency. Now that the emergency has been met fairly well with U. S. 33 and U. S. 12, more time will be taken to more thoroughly evaluate the new improved varieties.

VARIETY TEST UNDER SEVERE CURLY TOP EXPOSURE
S. D. BONAR FIELD - Buhl, Idaho - 1937

Variety	Acre Yield: Tons Indic. Avail. Sugar	Acre Yield: Tons Beets	Sucrose Percent	Coef. Apparent Purity	Percent Curly top July 28	Beets per 100 ft. row at harvest
622	2.443	15.28	17.45	91.59	16.89	103
611	2.130	13.17	17.79	90.97	17.49	101
612	2.087	12.95	17.73	90.79	26.83	103
623	1.872	12.05	17.06	91.12	25.65	92
610	1.868	11.65	17.54	91.28	35.68	98
U.S. 12 (618)	1.719	10.52	17.92	91.18	27.80	97
U.S. 33 (5642)	1.178	7.09	18.01	92.37	91.98	93
Old Type (5638)*		1.58		No sig.	100.00	
				F value		
S.E. Mean	0.124	.826	.221	0.70		
Diff.for 19:1 odds	.248	1.65	.442	1.40		
Diff.for 99:1 odds	.323	2.15	.575	1.82		

*Estimated results from adjacent test.

Note: This table is a result of averaging 12 replicated plots, each 60 ft. long. Half of the test was planted April 9 and the other half May 6. Harvested October 8 to 14, 1937.

Variety Test Under Medium Curly-Top Exposure
Hill Bros. - Granger, Utah - 1937
by Bion Tolman

Variety	Acre Yield: Tons Indicated Available Sugar	Acre Yield: Tons Beets	Sucrose Percent	Coefficient of apparent purity	Number of Beets per 100 ft. of row
622	3.447	26.28	15.01	87.46	90
612	3.341	24.90	15.30	87.27	90
611	3.333	24.66	15.53	86.78	94
623	3.331	25.35	15.17	86.91	93
610	3.301	23.22	15.97	88.73	90
U.S. 12 (618)	3.235	23.67	15.52	87.88	92
U.S. 33(5642)	3.194	22.14	16.13	89.14	94
Old Type (5638)		10.00*			
S.E. of Mean Difference	0.1067	0.4765	0.2955	0.8822	
Diff. for 19:1	0.211	0.95	0.59	1.76	
Signif. 99:1 Odds	0.281	1.24	0.77	2.29	
F Value	4.26	18.57	14.16	4.56	
5% point	1.59	1.59	1.59	1.59	
1% point	1.92	1.92	1.92	1.92	

*Acre Yield of Old Type calculated from the Weight of beets in a 6-row strip running through the center of the field.

Note: The above data are averages of 12 replications of 4-row plots 55 feet long. One half of the experimental field was given an extra heavy application of manure. Half of the replications on each fertility section were thinned to 8" and half to 20". The effect of both spacing and fertility levels was quite pronounced. In the above table these have all been averaged together. The analysis of variance was run on the complete tests which included 24 varieties (16 varieties in addition to the above 8). Planted April 13, harvested October 28, 1937.

Variety test - King City, California - 1937
by Charles Price

Variety	Acre Yields Calculated[1]: Tons Indicated Available Sugar	Acre Yields Calculated[1]: Tons Beets	Sucrose Percent	Coefficient of Apparent Purity
622	5.981	34.15	18.94	91.68
612	5.810	32.24	19.50	92.49
U.S. 33(5642)	5.792	30.65	20.41	92.64
610	5.691	31.08	19.73	93.14
623	5.683	33.31	18.66	91.65
S.E. of Mean Difference	0.2135	1.6101	0.38605	0.72346
Diff.for 19:1	0.4301	3.2427	0.77750	1.4571
Signif. 99:1 Odds	0.5744	4.3311	1.03847	1.94611
Z Value	0.7108	0.2947	0.8041	0.7123
5% Point	0.32903	0.32903	0.32903	0.32903
1% point	0.48355	0.48355	0.48355	0.48355

[1]Determined from normal competitive beets.

Note: Planted March 4, harvested October 5 & 6, 1937, with 6 replicated plots

and 10 varieties included in the test.
Variance analyses taken from complete data with 10 varieties.

Variety Tests With Regard To Bolting, 1937

Variety	Granger, Utah	Salinas, Calif.	Davis Calif.	Riverside, Calif. April 22	Riverside, Calif. May 18
U. S. 12 (618)	0.06	21.50	70.23	34.5	64.1
U. S. 33[1] (3407)	—	11.50	56.05	11.2	41.0
do (5642)	0.40	25.00	62.60	41.0	72.8
U. S. 14[2] (515)	—	6.00	27.36	0.3	4.3
do (617)	—	10.50	64.64	1.7	16.1
U. S. 15 (5651)	—	1.00	13.72	0.0	0.6
Old Type (5638)	—	4.08	24.43	0.4	3.6
610	0.40	23.50	50.55	8.1	34.9
611	0.00	5.50	44.39	5.1	24.3
612	0.32	16.50	50.45	22.0	52.5
622	0.06	10.00	43.75	2.7	18.3
623	0.06	--	—	4.5	22.7
Date of Planting	April 13 1937	Dec. 22 1936	Dec. 20 1936	October 23, 1936	
Date of Record	Aug. 1	May 27	June 10	April 22	May 18

1/ No. 3407 is the original U. S. 33 while No. 5642 is a second increase.
2/ No. 515 is the original U. S. 14 while No. 617 is the next increase.

VARIETY TRIALS OF MONITOR SUGAR COMPANY

G. W. Bradford
Monitor Sugar, Bay City, Michigan

Our work on the varietal tests which we conducted in the season of 1937 was divided into two parts. First, in our experimental field we made comparative tests of 3 American and 12 European varieties of seed. Four replications of each variety were made in plots 8 rows wide and 100 feet long. The stand of beets was somewhat reduced by the presence of black root, although a fairly even stand was secured.

A moderately severe infestation of leaf spot set in about August 1. Under such conditions as these the variety U.S.D.A. #217 was superior to all other varieties in this field in sugar per acre produced, in sugar content of beets and average weight of the individual beets. Two other varieties in this field yielded only slightly higher tonnage but their sugar content was significantly lower. Yields of the fifteen varieties ranged from 7.6 to 10.6 tons per acre. Sugar content varied from 12.91 to 15.33 percent. From 2167 to 3206 pounds of sugar per acre was produced by these different varieties.

The second part of our variety tests consisted of field trials of No. 217 in different parts of the territory served by the Monitor Sugar. These plots occupied from 1/2 acre to 2 acres in commercial fields of our beet growers and were under the direct supervision of our fieldmen. We obtained complete data on 14 fields on which these comparisons were made.

The average yield per acre for these comparisons were as follows:

#217 - 9.612 Tons	Commercial - 8.199 Tons	1.4 Tons in favor #217

Sugar Content:

#217 - 15.40%	Commercial - 14.66%	.74% in favor #217

Sugar per Acre

#217 - 2959 Lbs.	Commercial - 2431 Lbs.	528 lbs. in favor #217

Leaf spot infestation was from medium to severe throughout our territory last season. Number 217 proved to be just what the name implies, blight resistant, but not immune to this disease of sugar beets. It showed resistant qualities when the disease became prevalent and made a quicker recovery than other varieties where the crop was hard hit. These field trials aroused considerable interest among our beet growers and we already have many requests for this seed for the next crop. We plan on planting about 200 acres of this variety for 1938 and now we are interested in seeing how #217 yields in comparison with other varieties in a season when there is no leaf blight.

THE MINNESOTA SYSTEM FOR TESTING AND RECOMMENDING VARIETIES*

F. R. Immer
Division of Agronomy and Plant Genetics, University of Minnesota

Testing of varieties of grain or of corn hybrids is carried on at the central experiment station located at University Farm, St. Paul, and in cooperation with the branch experiment stations in southeast, west central, northwest, north central, and northeast Minnesota. In some cases, particularly with corn, tests are arranged on farmers' fields located in strategic regions of the state. The plan is to test over as wide an area of the state as the varieties would seem to be adapted to.

A uniform yield test of promising new strains of spring wheat and standard varieties, entered by the different states in the hard red spring wheat area, is conducted in 20 places in the 7 states cooperating in spring wheat improvement. Such tests furnish advance information on new strains which seem most promising in adjoining states as well as information on regional adaptation both between and within states. A representative of the U.S. Dept. of Agriculture acts as the coordinator in these uniform yield trials of spring wheat.

The decision to recommend a new variety for distribution to the farmers rests with the annual conference of workers from the Divisions of Agronomy & Plant Genetics and of Plant Pathology & Botany, the cereal technologists (in the case of wheat), and the agronomists of the branch experiment

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stations. To this conference is presented all available information regarding the new variety and the vote of this conference alone can recommend its release and distribution. No variety of grain or corn hybrid can be recommended for release to the farmers of Minnesota until it has been tested for a minimum of three years and in several places in the state. This same annual conference draws up a recommended list of varieties with their characteristics and specifies in which regions of the state they are to be recommended for growing.

After a new variety of grain has been recommended for distribution to the farmers the seed supply is increased at the central and branch experiment stations. The seed is then sold to the farmers, at a fair price for pure seed. When the demand for the new variety is great the seed is distributed under the Approved Grower Plan. Under this plan the experiment station decides how much seed shall be allocated to each county. The distribution within the counties is then placed in the hands of a committee of five, consisting of the county agent, the state extension agronomist, and three farmers appointed by the president of the Minnesota Crop Improvement Association.

The central and branch experiment stations maintain stocks of pure seed of all the recommended varieties. These are for sale as foundation seed stocks for growers interested in producing registered seed.

The present plan for the distribution and control of the seed of corn hybrids calls for the initial increase and control of the inbred lines under the revolving fund of the Division of Agronomy & Plant Genetics and in cooperation with the Minnesota Crop Improvement Association. It is the intention to produce sufficient seed of the first crosses (used in the production of 3-way and double crosses), to supply the needs of the growers, these increases being made under the direction of the certification official of the Crop Improvement Association. This official is furnished by the University and is in charge of seed distribution at University Farm. Seed of the F_1 crosses is sold to the growers who are interested in producing seed of the double crosses or 3-way crosses.

The testing program for the small grains involves preliminary yield tests in replicated rod row tests. Except during the first year, when insufficient seed compels the use of single rod row plots, plots of 3 rod rows are used and only the central row harvested. Three replicates are used, usually, and the tests conducted at two or three branch experiment stations in the state after the first year as well as at the central station located at University Farm. The total number of replications in all tests in a given year is usually twelve.

Studies on reaction to diseases are made in a special disease garden, under epidemic conditions, at University Farm, in cooperation with the Division of Plant Pathology. These studies are conducted both during the segregating generations as an aid in selection and during the period that purified hybrids are grown in yield trials. Wheat is tested for resistance to stem rust, leaf rust, black chaff, bunt, loose smut, scab and stripe. Oats is tested under epidemics of stem rust, crown rust and the smuts. Barley is tested for resistance to stem rust, loose smut, scab and stripe. Flax is tested for resistance to rust and wilt.

After one to three years in rod rows, usually three, the most promis-

ing strains are placed in 1/40 acre plots replicated three times at three to six places in the state. Yield tests are conducted for a period of three years before a new variety can be recommended for distribution to the farmers.

Milling and baking tests are made on the most promising wheat varieties in cooperation with the Division of Agricultural Biochemistry. In the future promising new varieties of barley will be tested for malting quality in cooperation with the malting barley laboratory located at Madison, Wisconsin. The oil percentage and iodine number of varieties and hybrids of flax is determined by a commercial linseed oil company in Minneapolis.

In the breeding of corn hybrids the most promising inbred lines are top crossed to an adapted commercial variety and the general combining ability of the inbreds determined from such top cross tests. Such tests are made in replicated yield trials using three or four replications in each of several places in the state, usually having ten or twelve replications in all. The inbred lines which have the best combining ability are selected from this test and crossed in all combinations to provide F_1 crosses. These are in turn tested in the same type of experiments as the top crosses with about the same number of replications. From the yield data on the F_1 crosses it is possible to predict with fair accuracy which F_1 crosses should be combined to produce double crosses.

Double crosses are made in such a way that the predicted yield is the greatest. These double crosses are then tested in about ten or twelve replications, as a total of several places in the state, for a three year period. The poorest crosses are discarded after the first or second year of test. Notes on diseases and agronomic characters are taken in all of the above corn yield trials. Data on smut reaction is taken under smut epidemic conditions.

In the rod row tests with small grains and in the corn tests of top crosses, F_1 crosses and the initial double crosses tests the number of strains to be tested is relatively large. For such yield trials the two dimensional quasi-factorial design is to be employed for future experiments. In the 1/40 acre plot trials with small grains and the advanced double cross tests where the number of strains to be tested does not, usually, exceed twenty the ordinary randomized block methods are used.

RELATIONSHIP OF SEED BALL SIZE TO GERMINATION AS FOUND TO BE COMMON TO BEET SEED GROWN OVER THE ST. GEORGE AREAS

F. S. Ingalls, Utah-Idaho Sugar Company

In discussing relative germination as between standard seed and small seed fractions, we will deal with relative germination values established between the standard seed and small seed resulting from process during periods the various types of seed were cleaned. We shall consider the standard seed and the small seed associated with a particular standard in two series—Series "A" to be representative of the higher germinating lots of standard seed from each type considered, and the "B" Series representative of the lower

germinating lots of standard seed for each type considered; all seed being a part of the large-scale increases grown and harvested either over or tributary to the St. George areas. The term "standard seed" as used in this paper refers to seed remaining on 3 mm x 3/4" slotted screen after screening processes have been completed.

Samples of standard seed used for test were collected through an automatic sampler fitted into receiving hopper immediately below the clean seed weighing scales at St. George, and the small seed composite sample was made up from periodic catch samples as the small seed was transferred from beneath the screens. Each sample amounting to about 700 grams was thoroughly mixed and passed through a Boener sampler. Fractions amounting to about 20 grams were accepted for examination. Three lots of 100 seed each were counted out for germination, transferred to a 2-ounce beaker and soaked for 2 hours in tap water at 20° temperature. The water was then drawn away, and the adhering extract washed from the seed. The surface water was removed from the washed seed by gently rolling the seed between folds of Scott tissue. After drying processes the seed was immediately placed between folds of blotters which were kept moist enough so that water would show when the blotters were squeezed between thumb and finger. When properly indexed the pads are placed on trays in an electric seed germinator, two sets of which are used—the first automatically controlled to maintain a constant temperature of 30°C. and the second automatically regulated to hold a temperature of 20° C. At regular intervals over each 24 hours during the entire germinating period, the seed are subject to temperature change. Through transfer of the pads between the two germinators held at desired temperatures, a sharp temperature difference is realized within a relatively short period.

Germination counts were commenced on the fourth day, and all germinated seed balls with sprouts were discarded. At the end of the eighth day a second count was made, and the non-germinating balls in each sample were then transferred to a fresh pad which is used for the balance of the germination period. At conclusion of the germination period, the final counts were made, and counts from each of the three pads were accepted provided differences in the count between pads did not exceed the tolerant limits for the test. The seed type studied, both standard and small seed fractions, embraces Series "A" and "B" of the following types, all of the curly-top resistant strain:

U. S. #12
U. S. #34
U. S. #33
A-600

GERMINATION PERCENT OF STANDARD
SEED REMAINING ON 3 MM SCREEN CONSIDERED STANDARD

SEED THROUGH / SEED REMAINING		3MM	3.00 MM 2.75 MM	2.75 MM 2.50 MM	2.50 MM 2.00 MM	2. MM
Seed Type, U. S. #12 Series	(a)	100.00	47.9	41.4	37.1	7.6
" " " " "	(b)	100.00	44.9	17.0	10.8	3.1
Seed Type, U. S. #33 Series	(a)	100.00	38.2	26.5	6.4	1.7
" " " " "	(b)	100.00	60.2	51.1	18.5	2.6
Seed Type, U. S. #34 Series	(a)	100.00	59.5	49.2	12.9	5.9
" " " " "	(b)	100.00	42.9	23.3	8.6	3.7
Seed Type, A-600 Series	(a)	100.00	50.9	39.8	24.1	8.4
" " " "	(b)	100.00	33.3	19.6	13.7	1.9

U. S. #12

GERMINATION PERCENT OF STANDARD

	Series "A"	Series "B"
Standard	100.00	100.00
Thru 3 MM Remaining on 2.75 MM	47.9	44.9
Thru 2.75 MM Remaining on 2.50 MM	41.4	17.0
Thru 2.5 MM Remaining on 2 MM	37.1	10.8
Thru 2 MM	7.6	3.1

U. S. #33

GERMINATION PERCENT OF STANDARD

	Series "A"	Series "B"
Standard	100.00	100.00
Thru 3 MM Remaining on 2.75 MM	38.2	60.2
Thru 2.75 MM Remaining on 2.50 MM	26.5	51.1
Thru 2.5 MM Remaining on 2 MM	6.4	18.5
Thru 2 MM	1.7	2.6

U. S. #34

GERMINATION PERCENT OF STANDARD

	Series"A"	Series "B"
Standard	100.00	100.00
Thru 3 MM Remaining on 2.75	59.5	42.9
Thru 2.75 MM Remaining on 2.50 MM	49.2	23.3
Thru 2.50 MM Remaining on 2 MM	12.9	8.6
Thru 2 MM	5.9	3.7

A-600

GERMINATION PERCENT OF STANDARD

	Series "A"	Series "B"
Standard	100.00	100.00
Thru 3 MM Remaining on 2.75 MM	50.9	33.3
Thru 2.75 MM Remaining on 2.50 MM	39.8	19.6
Thru 2.50 MM Remaining on 2.00 MM	24.1	13.7
Thru 2 MM	8.4	1.9

GERMINATION TESTS WITH SUGAR BEETSEED*

A. W. Skuderna and C. W. Doxtator
American Beet Seed Company

Germination tests conducted on 172 samples of beetseed in quadruplicate were made at Rocky Ford, Colorado, during 1935, 1936 and 1937. The purpose of this study was to develop if possible a standard method of procedure for use by the sugar beet industry. Three different types of germination beds were used, namely, paper toweling, blotting paper, and fine grained sterilized river sand. The results of this work indicate that either paper toweling or blotting paper is preferable to sand as a germination bed. Further, germination and sprout counts were made 30 or more percent faster when either paper toweling or blotting paper was used as a germination bed.

Tests were made with four temperature methods, these being, first, a continuous temperature of 20° C. for the entire period of test; second, a continuous temperature of 30° C. for entire period of test; third, an alternating temperature of 20° C. for 16 hrs., and 30° C. for 8 hours daily for period of test; and fourth a temperature of 30° C. for the first 24 hours and then alternating the temperature 16 hrs. at 20° and 8 hours at 30° C. for period of test. Method 1 and method 4 proved best in this set of results...Further work is necessary to establish best temperature method.

Tests conducted with various size seedballs indicate a positive correlation with seed size and germination. Seedballs were graded into 4.00 mm., 3.5 mm., and 2.5 mm. sizes. The larger the seedball the higher the germination, and greater number of sprouts obtained with the kind of seed used in these tests. The results were as follows:

*This paper will appear in detail in the April issue of the Journal of Agronomy.

4.0 mm	3.5 mm	2.5 mm	Random Size
92.79%	87.79%	74.0%	84.88%
225 sprouts	169 sprouts	119 sprouts	177.54 sprouts

These results indicate that to eliminate bias in preparation of a sample the use of a mechanical grain sampler (such as Boerner) is necessary to secure a representative sample.

Tests conducted on presoaking of seed for 2 hours prior to conduct of germination test versus dry seed, show that with beetseed from a fresh crop this treatment is not necessary, unless presence of toxic substances in the seed coat has been shown. However, on older seed, the presoaking treatment is beneficial.

Tests were conducted in using tap water and distilled water in moistening the paper toweling, blotting paper and sand, and in presoaking of seed. The results obtained indicate that when the tap water is available of the quality indicated in these tests (about 800 p.p.m. mixed salts) there is no advantage to be gained in distilled water.

Tests conducted with different lengths of germination period, indicate that reporting of results at the end of 10 days is preferable to waiting 14 days before concluding the test. It would seem that for practical field purposes the germination count obtained on most germination tests at the end of 7 days is the important consideration from standpoint of producing vigorous seedlings of uniform size. Apparently, greater emphasis should be placed on vigor and condition of seedlings than relying entirely on percentage germination as a sole index of acceptability of seed.

Conclusion

The results of tests discussed in this summary of results from work conducted in 1935 - 1936 - 1937, indicate the need of a random sample of beetseed (mechanically reduced to proper sample size), presoaking seed (especially older seed) the choice of either paper toweling or blotting paper, reporting results of test at end of 10 days, and supplementing laboratory tests with field test wherever possible so as to determine vigor of seedling plants. Germinating beetseed at cooler temperatures appears desirable. The tentative choice of a 20° C. continuous temperature seems warranted by these tests. Further work on this point is necessary to establish best temperature methods.

SOME FACTORS WHICH INFLUENCE THE RATE AND TOTAL PERCENTAGE GERMINATION OF SUGAR BEET SEED

Bion Tolman and Myron Stout
U.S.D.A.

Seeds from various varieties of sugar beets vary in both rate and total percentage germination. This difference between varieties is largely dissipated when the naked seeds are germinated after being removed from the corky pericarp. Toxic substances are present in the seed ball which affect both rate and total germination, and which when present in sufficient con-

centration totally inhibit germination. These substances are water soluble, insoluble in ether, acetone and toluene, and partially soluble in absolute ethyl and propyl alcohol. The toxic effect of a water extract from seed balls on the germination of naked sugar beet seeds is not diminished by boiling the extract. Some toxic substances remain in the ash of the water soluble extract.

Pre-germination subsequent to alternate soaking and drying of the seed gives a further increase in rate and total percentage germination.

EXPLORATORY STUDIES IN SEED GROWING UNDER DIFFERENT CLIMATIC CONDITIONS

George T. Scott
West Coast Beet Seed Committee

Up to the present, beet seed growing has been largely confined to areas in the southwestern United States where relatively mild winter temperatures are the rule. Under such conditions, with most of the curly-top resistant strains now in use, the bolting requirement has been met and satisfactory yields of good quality seed have been produced. On the other hand, some of the newer strains which have a higher bolting requirement, when planted in these warmer areas, have been disappointing in seed production.

It has been observed that in the case of some strains which may bolt in sufficient percentage in the milder areas to produce a fair yield of seed yet fall short of 100% bolting. As might be expected in the case of a crop of seed produced under conditions where bolting is less than 100% there is brought a selection in favor of bolting, i.e., that fraction of a variety with the least bolting tendency is automatically eliminated from the seed increase. It is that fraction which is most desirable from the standpoint of the beet grower and the processor.

It is possible that with some changes in cultural methods, such as earlier planting, heavier nitrogen fertilization, etc. in the warmer areas, the situation may be remedied by increasing the percentage of bolting in a given variety, however, since the main factor involved seems to be one of temperature the obvious remedy, especially with varieties of higher bolting requirement is to grow these varieties in colder areas.

One phase of the work of the West Coast Beet Seed Committee is to make exploratory studies in seed production in northern areas or where the exposure of the crop to cold would be greater. We have also found that in addition to proper temperatures, good soil, adequate moisture, etc., another requirement which is equally important if we are to expect any permanency in beet seed growing is good farmers.

During the past season we had small plantings in two of the smaller valleys of Northern California and in the Tulelake district which is part of the Klamath basin. In two of these we later found that we were late with our planting date so that the beets as they went into the winter were of such small size that considerable winter injury resulted. Plants which survived the winter grew well in spring and later produced nice quality seed.

The most interesting planting of an exploratory nature was one put in with the Branch Experiment Station of Oregon Agricultural College at Talent, Oregon. This planting had better care than most of our plantings in the northern area and responded accordingly. In this planting were included the following varieties: U. S. 12, U. S. 14, U.S. 33, U.S. 550 and A-600. Of this list #12 and #33 bolt fairly easily, the others, #14, #550 and A-600 are in their original stock comparatively refractory bolters. Under the conditions of this test these moderately difficult bolters responded about equally to U.S. 12 and 33. The yields of seed of these varieties, calculated to acre basis were as follows:

U.S. #12	-	2818#	-	88.75% germ
U.S. #14	-	3243#	-	85.50% "
U.S. #33	-	3412#	-	91.75% "
U.S. #550	-	2790#	-	81.75% "
A-600	-	3538#	-	82.25% "

GROWING SUGAR BEET SEED UNDER DIFFERENT CLIMATIC CONDITIONS

Bion Tolman, C. H. Smith and Albert Murphy, U.S.D.A.

Experiments conducted in southern Nevada, southern Utah, northern Utah, and Idaho, reveal considerable information with regard to the possibility of growing sugar beet seed under a wide variety of conditions.

In southern Nevada the mild winter climate is conducive to considerable winter and early spring growth, and while excellent results are secured with certain commercial varieties now being grown, experiments have shown that non-bolting varieties cannot be reproduced there. In northern Utah seed has been grown for the past four years at elevations ranging from 4300 to 5500 feet. Here the best results have been secured at the higher elevations where temperatures are lower and where seed maturity is more gradual. In some instances damage has resulted from winter injury, but during four years experience no planting has been completely lost. Generally the yields of seed have also been satisfactory.

A more serious problem, particularly in Utah Valley, Salt Lake and Tooele Valley, has been injury to seed development from heat and possibly other unknown factors. Experiments are being conducted to determine the cause of this injury to germination, but some phases of the problem are very puzzling. Until more information is available commercial expansion of the seed industry will undoubtedly be towards regions where good quality of the seedcan be depended upon.

DATE OF HARVEST OF SUGAR BEET SEED

Charles Price, U.S.D.A.

Tests were conducted at Hemet, California, in two seasons. The first test was preliminary. In the second test, extensively randomized plots were

used and seven cuttings were made at weekly intervals. At each harvest date the plants were divided into three classes on the basis of seed or flower development and yields and germination were studied.

Significant differences in viability were not found among the various dates of harvest. There was, however, a significant drop in seed yield in the last cutting attributable to shattering of seed. From these results, it would seem desirable to advance the harvest date slightly and avoid the common practice of allowing full maturity of seed on the lower portions of the spike before cutting is started.

THE EFFECT OF PRECEDING CROPS ON SUGAR BEET SEED PRODUCTION

From tests conducted by the N. M. State College
W. B. Morrow, Western Seed Production Corporation

The two major crops grown in the Las Cruces area are cotton and alfalfa. All land planted to sugar beet seed has been preceded at some time or another by cotton or alfalfa, consequently, two separate tests were conducted, one on cotton ground and the other on previously cropped alfalfa land. Preceding crops selected for land that had been planted to cotton were corn for ensilage, spring wheat, Sudan grass, sesbania and cowpeas. Preceding crops chosen for ground that had previous alfalfa history were cantaloupes, spring wheat, corn for ensilage, and some alfalfa was allowed to remain as a preceding crop. This is possible because several cuttings of alfalfa can be made before turning under prior to planting beets, and in this case alfalfa can rightfully be considered a preceding cash crop. All of the preceding crops were harvested at maturity, or, as in the case of sesbania and cowpeas, they were turned under and utilized as a green manure crop. Where alfalfa was used as a preceding crop, two cuttings were harvested and the third cutting was plowed under a few days before beet planting time.

The sugar beet seed crop was planted the middle of September and some difficulty was encountered in securing stands, due to rains. On November 4th a very severe freeze (15 degrees) killed a number of small beets, thereby reducing the stand. However, this reduction was uniform throughout and there were no great variations in stands between treatments. The sugar beet seed crop did not receive any commercial fertilizer other than 100 pounds per acre of treble superphosphate at seeding time.

The following table draws the results of the sugar beet seed harvest.

Preceding Crops on Cotton Land

Treatment	Yield per Acre
Corn for ensilage	885 lb.
Spring wheat	933
Sudan grass	511
Sesbania	926
Cowpeas	1036
Summer fallow	1583

Difference required for significance - 357

Preceding Crops on Alfalfa Land

Treatment	Yield Per Acre
Alfalfa	1025 lb.
Cantaloupes	1670
Spring Wheat	1024
Corn for ensilage	1174
Summer fallow	2009

Difference required for significance - 341

CONCLUSIONS:

From the harvest results of the sugar beet seed crop several rather interesting comparisons can be made.

The preceding crops planted on cotton land as compared to summer fallow show rather conclusively the amount of plant food that they have taken away from the following sugar beet seed crop. Also in the case of the treatment of Sudan grass, in addition to utilizing plantfood, it has left the soil in a rather toxic condition, which is evidenced by the extremely low yield of sugar beet seed following Sudan grass.

The growing of the annual green manure crops on land previously in cotton did not increase sugar beet seed yields. It is believed that the reason for this is that the green manure crops were not turned under early enough to add their benefits to the sugar beet seed crop.

In the case of the preceding crops on alfalfa land, consideration must be given to the effect of the previous alfalfa history on the summer fallow treatment. This summer fallow treatment is in reality alfalfa turned under in the fall preceding the sugar beet seed crop, allowing the alfalfa to thoroughly decompose and give the soil the benefits of green manure. The alfalfa treatment was turned under several days before the beet seed crop was planted and therefore did not have time to thoroughly decompose and add its benefits to the sugar beet seed crop.

Cantaloupes, which is the second highest yielding crop on the alfalfa series, appears to be a very desirable preceding crop as it does not seem to be a highly soil-depleting crop and a large amount of green succulent material can be turned under after the cantaloupes are harvested.

SEED PRODUCTION CONSIDERATIONS IN CALIFORNIA

Irwin E. Farrar, Farrar-Loomis Seed Company

The observations made in this paper are limited to experience gained in the pure sugar beet seed district of Riverside County, California, a district set aside by law for the growing of seed from only those varieties of sugar beets resistant to curly-top. It is situated on the coastal side of the coast range of mountains near the foot of Mount San Jacinto, near Hemet. The elevation of this seed growing valley and its being surrounded by mountains

gives the area a much different climate than the coastal plain.

The first consideration in seed production is termed "seed consciousness." This means that the producer of sugar beet seed must have uppermost in his mind the farmer who is to plant the seed and the sugar mill that is to process the beet crop, for seed is the starting point of beet sugar production. Every effort should be made by the producer to place in the hands of the sugar company for distribution to the beet grower a seed of high viability, of uniform size, and free from noxious weeds.

Sugar beet seed production succeeds when the right thing is done at the right time.

Not every farmer can adapt himself to the exacting practices necessary to produce a profitable crop of seed. Choice of proper soil type in the proper rotation is a primary essential that must be given study and attention. Sugar beet seed does best when planted within a very limited time. Records show that fields planted between September 1 and 20 yield on the average 500 to 600 pounds more per acre than those planted between September 20 and 30. The production dropped very markedly when for any reason a field got in as late as October, the yield being about 900 pounds per acre below the early planting dates. The very late planted fields always show a lower germination and a much heavier cleanout. Bolting percentage is, of course, higher in the fields planted in proper time.

Reasonable thickness of stand plays its part in production and bolting. All other factors being equal, results show that when stands fall below 6 plants per foot of row the percentage of bolters drops and the yield is reduced as much as 500 pounds per acre. Much attention has been given in the Hemet territory toward securing good stands of beets planted between the dates of August 25th and September 15th.

Fertilization has been given much attention in the experiments of the Department of Agriculture near Hemet, and in the commercial fields. Excellent results are obtained with manure plowed under four weeks or more before planting plus the addition of nitrogen as a side dressing during the growing periods of the crop.

Consistent and regularly timed irrigation must be practiced to secure good stands and harvest a crop of high viability. Too much water can be used and certainly too little will show distinct unfavorable results. It has been clearly demonstrated that ample moisture is needed during the blooming period so that no wilting will take place and as a further aid to mature a well filled seed ball.

The moisture requirements of the beet seed plant during April, May, and June must be heavy when it is taken into consideration that the growth is rapid and the leaf and stalk area becomes very large and heavy. Bolting starts the first week of April, and during the following six weeks the seed stalk makes a growth of 72" to 84" with a corresponding leaf development. The total green material from a representative field harvested this past summer has been measured by the 5 to 1 ratio, that is, one pound of dry material equals five pounds of green matter. This field of 21 acres produced 124 tons, 147 pounds, of dry straw, seed and screenings. This gives us a total of 620 tons, 735 pounds, green matter or 29 tons, 1082 pounds per acre. It is obvious

that to provide moisture and humidity for such a mass, irrigation must be consistently regular, and mother nature must aid by providing some air humidity.

TREATMENT OF SUGAR BEETSEED

A. W. Skuderna
American Beet Seed Company

Treatment of sugar beetseed had been practiced in the Arkansas Valley in Colorado from 1919-1928, when all of the seed used for commercial beet plantings in the territory served by the American Crystal Sugar Company was treated with formaldehyde gas. This method of treatment proved practical and inexpensive, and was generally productive of some increase in sugar per acre yield.

During recent years, the Division of Sugar Plant Investigations experimented with dust treatment with beetseed. As a result of this work treated seed is extensively used in Minnesota, where farmers treat their seed requirements using dusts such as Ceresan at the rate of 3 to 4 ounces to 20 lbs. of seed. The stand count results in the great majority of cases have been in favor of the treated seed. (1)

In 1937, Drs. G. H. Coons and J. E. Kotila of the Division of Sugar Plant Investigations, Bureau of Plant Industry, U.S.D.A. sent 4 dusts to a number of companies for treatment of sugar beetseed. A series of well replicated plots was requested, the results from which were to be reported at the meeting of the American Society of Sugar Beet Technologists. The dusts used were:

1. 1937 "Ideal" a 1:1:1 mixture of copper carbonate, merchloride and urea, ground to a fine powder. Dosage 4 ounces to 15 pounds seed.

2. Copper carbonate — Dosage 4 ounces to 15 pounds seed.

3. Ceresan (2% Ethyl Mercuric Chloride). Dosage 4 ounces to 15 pounds of seed.

4. Ceresan 2 parts, copper carbonate 1 part. Dosage 3 ounces to 15 pounds seed.

The seed was mixed with required dosage of dust in a barrel churn for 5 minutes and following treatment planted in 5 replicated series in 8 row plots, some 300 feet in length. The results are shown in Table 1.

Table 1. Effect of Sugar Beetseed Treatment, on Tonnage Yield, Percent Sucrose, and Pounds Sugar Per Acre. Rocky Ford, Colorado, 1937.

Treatment	% Stand 10" basis	Tons Beets Per Acre	Percent Sucrose	Lbs. Sugar Per Acre
Ideal	96.6	16.82	14.53	6386
Copper Carbonate	97.3	16.35	15.02	6419
Ceresan	99.1	16.83	15.03	6610
Ceresan + Copper Carbonate	95.5	15.87	14.71	6100
No Treatment	93.7	15.28	15.24	6087
Required for 5% level of significance		.95	.71	549

(1) L. E. LeClerg - Treatment of Sugar Beetseed Increased Stand and Yield. Circ. 57 - Univ. Minn. Agr. Extension Division. 1937.

While none of the differences exceed the level of significance required, the difference in pounds sugar per acre is suggestively large in favor of the Ceresan treated seed compared with the untreated seed. As will be noted, the percent stand was satisfactory in all cases, even in the untreated plots. The results suggest that work of this nature should be conducted over a period of years, and in a large number of areas, to determine merits of seed treatment.

MINUTES OF BUSINESS SESSION OF THE AMERICAN SOCIETY OF SUGAR BEET TECHNOLOGISTS

11 A. M. January 13, 1938

Called to order by President A. W. Skuderna who presided.

Resolutions read by Dr. Robbins as follows:

To President Heber J. Grant,
Utah-Idaho Sugar Company,
Salt Lake City, Utah

The American Society of Sugar Beet Technologists, at its first session, wishes you to know that its members share with you the loss of Willard Tell Cannon. He was your faithful Manager for eight years; he was active in the capacity of Vice President of the U. S. Beet Sugar Association; he was vitally interested in every phase of sugar production and manufacture, and he always manifested a keen interest in research, upon which he felt the future of the industry depended. The sugar beet industry has suffered the loss of a liberal-minded, aggressive leader.

The Society desires to express its gratitude to Mr. Douglass Scalley and his committee on Local Arrangements, representing the Utah-Idaho Sugar Company, Amalgamated Sugar Company, Franklin County Sugar Company, Layton Sugar Company, and Gunnison Sugar Company for the splendid facilities provided the Society, for entertainment, and for making the stay of its members pleasant in every way.

The President Heber J. Grant, for his interest in the Society's activities, and his cheerful, inspiring, and very human address.

To the Honorable Governor Henry Blood, for his enlightening recital of this history of the sugar beet industry in Utah, and his firm belief in the sugar beet as a plant which means so much in western agriculture.

To the General Electric Company, and R. H. T. Plumb, for his graphic presentation of the topic "Light and Life."

To the Chamber of Commerce of Salt Lake City for its cooperation and assistance, and to the Press of Salt Lake City, for their full and accurate reporting of the sessions.

Mr. Heath moved adoption of the resolutions - unanimously passed.

Suggested changes in constitution and by-laws read by Secretary. After discussion of dues, Mr. McCreery moved that the dues be stated as per annum--motion carried.

Dr. Brandes suggested the addition of Article 9 of appointment within thirty days - unanimously approved by the Society.

Discussion of Article 5, followed by Nuckols motion that it be left as read - motion carried.

Nuckols moved adoption of constitution and by-laws as read and amended - motion carried.

Standardization Committee report accepted by the Society.

Nomination Committee report — President, N. R. McCreery
Vice President, J. E. Coke
Secretary-Treasurer, H. E. Brewbaker

Heath moved nominations be passed by unanimous ballot - motion carried.

Retiring president, A. W. Skuderna, turned over the gavel to the new President, Mr. N. R. McCreery.

Mr. Cannon moved group extend a vote of thanks to the previous officers and executive committee - motion carried.

Nominations for Advisory Committee:

West Coast - G. J. Daley and Geo. T. Scott
Inter-Mountain - Douglass Scalley, and Roy H. Cottrell
Eastern Slope - W. L. Lawson, H. E. Zitkowsky, C. V. Maddux
Eastern U. S. - Wm. Schmitt, and M. J. Buschlen
Canada - R. D. Brown
At Large - W. W. Robbins, G. H. Coons

Elcock moved acceptance of the committees reported and unanimous ballot for the nominees - motion passed.

Dahlberg moved that future general meetings be held biennially. This was amended to include sponsorship of regional meetings in alternate years, which would be arranged for and financed by the respective regions. Amendment and original motion were carried.

Robbins moved next meeting be held in Denver - motion carried.

The following report of the Committee on Standardization of Experimental Method was adopted and the committee discharged.

REPORT OF COMMITTEE ON STANDARDIZATION OF EXPERIMENTAL METHODS

The Standardization Committee presents the following recommendations as an acceptable basis for field plot tests, including experiments with varieties, fertilizers, and cultural practices. These recommendations are to be construed as general, and not as mandatory, for all kinds of conditions, it being fully recognized that sufficient control for one field might be quite insufficient for another.

Field experiments have been classified for this purpose into three groups:

1. Demonstrational—investigational tests.
2. Experimental tests with less than 25 varieties or treatment.
3. Experimental tests with 25 or more varieties or treatments.

Group 1 Demonstrational-investigational tests

With strip tests comparing two varieties or treatments paired strips should be 4 or more rows in width. Harvest entire strip, or if this is impractical, paired samples may be taken. If the latter method is used, pairs of samples, each sample not less than 2 rows by 30 ft. in length, are to be harvested for yield. The entire sample, or 20 roots taken at random from the sample, is to be used for the determination of percent sucrose and purity.

Paired samples should be taken as close together as possible allowing for border rows between the paired plots. Each pair of samples should be separated by approximately 100 feet in the row. Strips should preferably be replicated.

Group 2 Experimental tests with less than 25 varieties

For variety tests in which the total number of varieties does not exceed 24 the randomized block method is recommended. Plots should be 4 to 8 rows wide and 60 to 100 feet long, replicated a minimum of 6 times. For more critical experiments, the number of replications could be increased to ten. Latin Square arrangements are acceptable.

Two samples of not less than 15 to 20 beets per plot are recommended for sucrose and purity determinations. Each sample should be taken at random from the entire plot, preferably, previous to piling.

Group 3 Experimental tests with 25 or more varieties

In variety tests involving more than 25 varieties the two dimensional quasi-factorial arrangement in two, or three, groups of sets, or the symmetrical incomplete randomized block arrangement would seem to be most appropriate. Since these tests will be used largely on new strains in the breeding experiments smaller plots than recommended under No. 2 will often be necessary.

See:

Yates F. - A new method of arranging variety trials involving a large number of varieties. Jour. Agric. Sci. 26: 424-455. 1936.

Boulden, C. H. Methods of Statistical Analysis. 209 pp. Burgess Pub. Co. Revised Edition, 1937.

Methods of Harvesting

In demonstrational-investigational tests (1) harvest of all beets in the plot disregarding the competition factor is recommended. In experimental tests (methods 2 and 3) it is recommended that stand counts and yield of the entire plot or sampled area be taken. It may be advisable in certain cases to take competitive beet yields also.

Methods of Recording Data

See type example

Type Example

VARIETY TEST - UTAH - 1937

Variety	Acre Yield: Tons Indicated Available Sugar	Acre Yield: Tons Beets	Sucrose Percentage	Coefficient of Apparent Purity	Number of Beets per 100' of Row
1	3.316	24.05	15.97	86.40	132
2	3.175	22.47	16.55	87.05	134
3	3.151	23.12	15.69	86.89	133
4	3.121	22.54	16.12	86.48	132
5	3.119	22.34	15.97	87.48	130
6	3.041	20.66	16.85	88.45	133
7	2.989	21.92	16.16	86.01	131
8	2.822	21.16	15.64	85.57	134
S. Error of Mean Diff.	0.111	0.784	0.350	0.790	
Diff. For Odds 19:1	.222	1.57	0.74	1.66	
Significance Odds 99:1	.351	2.11	0.99	2.21	
Calculated F Value	2.43*	3.44**	6.57**	3.31**	

* Exceeds the 5% point
**Exceeds the 1% point

VARIANCE TABLE

Variation Due to	Degree of Freedom	MEAN SQUARES: Tons Indicated Available Sugar	Tons Beets	Sucrose Percentage	Coefficient of Apparent Purity
Between Blocks	7	1.655	9.727	1.855	7.866
Between Varieties	7	0.119	8.583	1.638	6.444
Remainder (Error)	49	0.049	2.490	0.249	1.945
Total	63	0.823	20.800	3.732	16.255

Plots - 4 rows 125 feet in length.
Arrangement 8x8 Latin Square.
Planted April 20, Harvested Oct. 24.

Respectfully submitted,

COMMITTEE ON STANDARDIZATION OF EXPERIMENTAL METHODS

H. E. Brewbaker, Chairman
J. E. Coke
F. V. Owen
C. W. Doxtator
H. W. Dahlberg
S. B. Nuckols

CONSTITUTION AND BY LAWS OF THE AMERICAN SOCIETY OF SUGAR BEET TECHNOLOGISTS ADOPTED AT THE FIRST ANNUAL MEETING

Name

ARTICLE I

The name of this organization shall be the AMERICAN SOCIETY OF SUGAR BEET TECHNOLOGISTS.

Object

ARTICLE II

The object of this Society shall be to foster all phases of sugar beet and beet sugar research, and to act as a clearing house for the exchange of ideas resulting from such work.

Membership

ARTICLE III

Any individual or business engaged in the sugar beet industry, or interested in the objects of this Society shall be eligible for membership.

Sections

ARTICLE IV

Section 1. In order to provide opportunity for the consideration of specialized subjects in all branches of sugar beet research, Sections shall be organized as needed.

Section 2. The division of subject matter among the sections shall be as follows:

(a) General agronomy including soils, fertilizers, field production and by-products.
(b) Genetics, breeding, seed and varieties.
(c) Plant diseases and insect pests.
(d) Sugar beet machinery.
(e) Chemistry.

OFFICERS OF THE SOCIETY

ARTICLE V

The officers of the Society shall be a President, Vice-President, and Secretary, who shall act as Treasurer. The Executive Committee shall consist of the President, Vice-President, Secretary-Treasurer, the immediate past President, General Program Chairman, and the Advisory Council.

ARTICLE VI

The Advisory Council shall consist of the following representatives: West Coast 2, Intermountain area 2, Eastern Slope 3, E. U. S. 2, Canada 1, and at large 2.

ELECTIONS OF OFFICERS AND ADVISORY COUNCIL OF THE SOCIETY

ARTICLE VII

The President shall appoint a Nominating Committee of three members in advance of the regular meeting. This Committee shall nominate one candidate for each of the officers of the Society. Further nominations may be made from the floor. Nominations for the Advisory Council shall be made by the Nominating Committee in counsel with the Society members assembled from each area; the nominations for members at large to be made by the nominating committee.

DUTIES OF OFFICERS OF THE SOCIETY

ARTICLE VIII

Section 1. The President shall be the Executive Officer of the Society. He shall preside over the meetings of the Society and its Executive Committee.

He shall appoint the General Program Chairman.

He shall continue to serve on the Executive Committee for the Society for one year following his retirement from the Presidency.

Section 2. The Secretary of the Society shall keep the business records of the Society.

He shall collect the Manuscripts on the general program and transmit them to the editor (when elected) for publication.

Section 3. The Executive Committee shall formulate the policies of the Society as a whole, subject to the approval of the Society.

It shall coordinate the activities of the different Sections.

It shall act upon all matters within the jurisdiction of the Society which arise between meetings of the Society.

OFFICERS OF THE SECTIONS AND THEIR DUTIES

ARTICLE IX

The General Program Chairman shall be assisted by the chairman of each of the sections whom he will appoint within 30 days after the close of the general meeting.

Each Sectional Chairman shall organize the program of his section and shall be responsible for conducting the sectional meetings at the general meetings of the Society.

PLACE AND TIME OF MEETING

ARTICLE X

The place of the meeting of the Society shall rotate, which place shall be determined at the previous general meeting of the Society, and due notice given to the members.

AMENDMENTS

ARTICLE XI

Amendments may be proposed (1) by the Executive Committee directly, or (2) by petition of any 10 members of the Society. Notice of the proposed amendments shall be submitted to the members at least 14 days before the ballot is taken. The amendment may be adopted by two-thirds vote of the members present at any general meeting.

If, in the opinion of the Executive Committee, the proposed amendment should be acted upon before the next annual meeting, it may be submitted to the members by mail. If it is approved by two-thirds of those returning their ballots within 30 days, it shall be adopted.

BY-LAWS

1. Dues

Annual dues for membership in the Society shall be $1.50 for individuals, $10.00 for smaller companies including one or two factory sugar producers, and $25.00 for larger companies. Members paying this fee shall be entitled to receive all of the official communications of the Society and to participate in all its activities.

2. Publications

All papers listed in the program of any regular meeting, or suitable abstracts thereof, shall, on recommendation of the Chairman organizing the program and on the approval of the Editor, be published in the Proceedings of the Society which shall go to all members who have paid their dues.

3. Collection of Dues

The Secretary-Treasurer of the American Society of Sugar Beet Technologist shall distribute to each member of the Society a program listing papers to be presented.

4. Committees

The Society and Sections shall appoint such standing and special committees as seem desirable for carrying on the work of the Society or Section.

5. Quorum

A quorum of the Annual Meeting shall consist of 10 percent of the members.

6. Amendments

These By-laws may be amended at any annual meeting by two-thirds vote of the members present.

AMERICAN SOCIETY OF SUGAR BEET TECHNOLOGISTS . . .

MEMBERSHIP Feb. 15, 1938

*(Not present at 1938 meetings)

Name	Address	Firm
Fred A. Abegg	1810 S. Main St.,Salt Lake,Utah	U. S. Dept. of Agriculture
Carl D. Adams	Sidney, Montana	Holly Sugar Corporation
L. F. Arnold	Gunnison, Utah	Gunnison Sugar Co.
F. R. Bach	2nd Nat'l Bank Bldg. Saginaw,Mich.	Michigan Sugar Co.
R. C. Barr	R.2,Bx 237, Woodland,Calif.	Central Calif.Beet Grow.Assn.
R. J. Barton	2319 Van Buren, Ogden, Utah	Amalgamated Sugar Co.
G. H. Bernheisel	Paulding, Ohio	Paulding Sugar Co.
A. E. Benning	Nyssa, Ore.	Amalgamated Sugar Co.
Ernest Bennion	Picture Butte, Alberta, Canada	Canada Sugar Factories
M. F. Bowen	Box 838, Grand Junction, Colo.	U. S. Dept. of Agriculture
G. M. Bradford	Bay City, Mich.	Monitor Sugar Co.
E. W. Brandes	Washington, D. C.	In Charge—Div.Sugar Plant Inv., U.S.D.A.
H. E. Brewbaker	Longmont, Colo.	The Great Western Sugar Co.
H. D. Brown	Chatham, Ontario, Canada	Canada & Dominion Sug.Co.Ltd.
W. A. Budge	Logan, Utah	Amalgamated Sugar Co.
G. L. Buhrman	Paulding, Ohio	Paulding Sugar Co.
M. J. Buschlen	Saginaw, Michigan	F. & M. Beet Sugar Assn.
H. L. Bush	Brush, Colo.	National Seed Co.
D. D. Buttars	Lewiston, Utah	Amalgamated Sugar Co.
J. W. Calland	Decatur, Indiana	Central Sugar Co. Inc.
Collins T. Cannon	69 D St.,Salt Lake City, Utah	Utah-Idaho Sugar Co.
W. Y. Cannon	Box 2010 " " " "	" " " "
John W. Carlson	Logan, Utah	U.S.Dept. of Agriculture
Eubanks Carsner	P.O. Box 752, Riverside, Calif.	" " " " "
Carlyle Chaffin	Idaho Falls, Idaho	Idaho Beet Growers Assn.
C. A. Christensen	Brigham City, Utah.	Utah-Idaho Sugar Co.
Paul H. Clute	Phoenix, Arizona	Western Seed Prod. Corp.
Wm.P.Christensen	Shelley, Idaho	Utah-Idaho Sugar Co.
C. J. Cobbley	Pleasant Grove, Utah	" " " "
J. Earl Coke	2 Pine St. San Francisco,Calif.	Spreckels Sugar Co.
William C. Cook	Modesto, Calif.	U. S. Dept. of Agriculture
Samuel Cook	Layton, Utah	Layton Sugar Co.
*G. H. Coons	Washington, D. C.	Div.Sugar Plant Inv.U.S.D.A.
C. E. Cormany	Sheridan, Wyo.	Holly Sugar Corp.
R. H. Cottrell	Ogden, Utah	Amalgamated Sugar Co.
L. E. Crookston	Logan, Utah	" " "
H. W. Dahlberg	Denver, Colo.	The Great Western Sugar Co.
G. J. Daley	Stockton, Calif.	Holly Sugar Corp.
M. R. Dalhing	417-8th St., Idaho Falls, Ida.	Utah-Idaho Sugar Co.
Geo. H. Davis	Garland City, Utah	" " " "
L. O. Doneen	Davis, Calif.	University of California
Howard Dorst	Logan, Utah	U. S. Dept. of Agriculture
J. R. Douglass	Twin Falls, Idaho	" " " " "
C. W. Doxtator	Rocky Ford, Colo.	American Beet Seed Co.
Harry A. Elcock	Twin Falls, Idaho	Amalgamated Sugar Co.
Jas. E. Ellison	Layton, Utah	Layton Sugar Co.
Arthur Eskelsen	Belle Fourche, So. Dak.	Utah-Idaho Sugar Co.
L. W. Eskilsen	Findlay, Ohio	Great Lakes Sugar Co.
R. J. Evans	Logan, Utah	Utah State Agri. College

Name	Address	Firm
Irwin E. Farrar	Hemet, Calif.	Farrar-Loomis Seed Co.
Robert S. Gaddie	Box KK, Toppenish, Wash.	Utah-Idaho Sugar Co.
John O. Gaskill	Ft. Collins, Colo.	U. S. Dept. of Agriculture
Hatler Gearheart	Chinook, Montana	Utah-Idaho Sugar Co.
N. J. Giddings	Riverside, Calif.	U. S. Dept. of Agriculture
Jesse R. Green	Bozeman, Montana	Montana Experiment Station
V. S. Hardy	544 Market St., San Francisco, Calif.	Hardy Seed Co.
D. Stanford Harris	Layton, Utah	Layton Sugar Co.
Thos. Heath	Preston, Idaho	Franklin County Sugar Co.
Orin R. Hills	Grand Junction, Colo.	U.S. Dept. of Agriculture
Lester J. Holmes	Clarksburg, Calif.	American Crystal Sugar Co.
R. L. Howard	Toppenish, Wash.	Utah-Idaho Sugar Co.
David P. Howells	Box 2010, Salt Lake City, Utah	" " " "
Oliver Humphreys	Sugar City, Idaho	" " " "
Noble Hunsaker	Brigham City, Utah	Utah Sugar Beet Growers
F. R. Immer	University Farm, St. Paul, Minn.	University of Minnesota
Frank S. Ingalls	Salt Lake City, Utah.	Utah-Idaho Sugar Co.
*Albert Isaksson	Longmont, Colo.	The Great Western Sugar Co.
J. F. Jarrell	" "	" " " " "
J. E. Jensen	6500 So. State, Salt Lake City, Utah.	Utah-Idaho Sugar Co.
Moroni Jensen	Richfield, Utah	Utah-Idaho Sugar Co.
Vernal Jensen	Ogden, Utah	" " " "
J. C. Keane	1584 Laird, Salt Lake City, Utah	" " " "
Wesley Keller	Logan, Utah	U.S. Dept. of Agriculture
John E. Kelley	Shelley, Idaho	Utah-Idaho Sugar Co.,
W. L. Lawson	Colorado Springs, Colorado	Holly Sugar Corp.
L. D. Leach	Davis, Calif.	University of California
Carl G. Leonard	Filer, Idaho	Idaho Beet Growers Assn.
G. R. Lewis	Twin Falls, Idaho	Amalgamated Sugar Co.
Jarod Lewis	Preston, Idaho	Franklin County Sugar Co.
Stanley Lewis	Rigby, Idaho	Utah-Idaho Sugar Co.
Frank F. Lynes	Sheridan, Wyo.	Holly Sugar Corp.
Thos. C. McBeath	809 4th St., W., Calgary, Alberta	Fertilizer Div. C.M.& S.Co.
S. W. McBirney	Davis, Calif.	University of California
W. C. McCall	Anaconda, Mont.	Anaconda Copper Mining Co.
N. R. McCreery	Denver, Colo.	Great Western Sugar Co.
B. O. McCulloch	Burley, Idaho	Amalgamated Sugar Co.
F. W. McEntire	P.O. Box 2010, Salt Lake City, Utah	Utah-Idaho Sugar Co.
*B. F. McGreevy	Longmont, Colo.	Great Western Sugar Co.
C. V. Maddux	Denver, Colo.	" " " "
J. W. Madsen	Great Falls, Mont.	Utah-Idaho Sugar Co.
J. R. Mason	Billings, Montana	Great Western Sugar Co.
Asa C. Maxson	Longmont, Colo.	" " " "
E. J. Maynard	Billings, Montana	Maynard Brokerage Co.
S. C. Meredith	San Francisco, Calif.	Spreckels Sugar Co.
E. M. Mervine	Fort Collins, Colo.	U. S. Dept. of Agriculture
W. Z. Morehouse	Layton, Utah	Layton Sugar Co.
W. B. Morrow	Las Cruces, New Mexico	Western Seed Prod. Corp.
Albert M. Murphy	Box 826, Twin Falls, Idaho	U. S. Dept. of Agriculture
S. B. Nuckols	Scottsbluff, Nebr.	" " " " "
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E. F. Ogborn	Betteravia, Calif.	Union Sugar Co.
F. V. Owen	1810 S. Main St., Salt Lake City	U.S. Dept. of Agriculture
W. W. Owens	Logan, Utah	Utah State Agri. College
A. E. Palmer	Lethbridge, Alberta, Canada	Dominion Experimental Farms
R. L. Partridge	Windsor, Colo.	Great Western Sugar Co.

Name	Address	Firm
W. H. Paulsen	Spreckels, Calif.	Spreckels Sugar Co.
Ray A. Pendleton	Davis, Calif.	U. S. Dept. of Agriculture
R. L. Piemeisel	P.O.Box 826, Twin Falls, Ida.	" " " " "
Chas. L. Pioda	Spreckels, Calif.	Spreckels Sugar Co.
Charles Price	Riverside, Calif.	U. S. Dept. of Agriculture
J. W. Randall	Ogden, Utah	Amalgamated Sugar Co.
Miss Betty Ransom	737 Terminal St.,Los Angeles, Calif.	Ransom Seed Laboratory
A. V. Reese	Smithfield, Utah RFD #1	Amalgamated Sugar Co.
D. J. Roach	Scottsbluff, Nebraska	Great Western Sugar Co.
W. W. Robbins	Davis, Calif.	University of California
J. H. Roskelley	Smithfield, Utah	Amalgamated Sugar Co.
Douglass Scalley	Salt Lake City, Utah.	Utah-Idaho Sugar Co.
Paul D. Scally	Toppenish, Wash.	" " " "
W. F. Schmitt	2206 Jefferson Ave., Toledo,Ohio	Great Lakes Sugar Co.
Geo. T. Scott	Berkeley, Calif.	West Coast Beet Seed Committee
G. H. Siegumfeldt	Bogholderalle 75# Vanlose, Copenhagen, Denmark	Danish Sugar Beet Seed Co.
*S. F. Sherwood	Washington, D. C.	Div.Sugar Plant Inv.,U.S.D.A.
A. W. Skuderna	Rocky Ford, Colo.	American Beet Seed Co.
Clifton H. Smith	259 Westminster Ave., Salt Lake City, Utah	U.S.Dept. of Agriculture
D. E. Smith	Jerome, Idaho	Amalgamated Sugar Co.
E. P. Soule	544 Market St., San Francisco, Calif.	Hardy Seed Co.
Myron Stout	1115 Windsor St.,Salt Lake City	U. S. Dept. of Agriculture
R. H. Tallman	Twin Falls, Idaho	Amalgamated Sugar Co.
Fred G. Taylor	Box 2010, Salt Lake City, Utah	Utah-Idaho Sugar Co.
Jed Taylor	Blackfoot, Idaho	" " " "
Frank R. Taylor	Raymond, Alta. Canada	Canadian Sugar Factories Ltd.
Bion Tolman	Salt Lake City, Utah	U.S.Dept. of Agriculture
Wm. Valgardson	Taber, Alta.Canada	
Hy. A. Vallez	Bay City, Mich.	Isabella Sugar Co.
H. B. Walker	Davis, Calif.	University of California
Le Grande Ward	North Ogden, Utah	Amalgamated Sugar Co.
W. H. White	Washington, D. C.	Principal Entomologist,USDA
Carl Whitesides	Layton, Utah	Layton Sugar Co.
Horace N. Whitney	Box 2010, Salt Lake City, Utah	Utah-Idaho Sugar Co.
Ralph W. Watson	Toppenish, Wash.	Utah-Idaho Sugar Co.
M. B."Scotty" Wilson	Missoula, Mont.	American Crystal Sugar Co.
Frank Wood	Trenton, Utah	Utah State Beet Growers
T. Geo. Wood	Raymond, Alta. Canada	Canadian Sugar Factories, Ltd.
G. P. Wright	Sacramento, Calif.	Spreckels Sugar Co.